Co-funded by the
Erasmus+ Programme
of the European Union

Rethinking EDUCATION

A Framework for Contextualizing Environmental Education Practice & Urban Green Management in Cities

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A thesis submitted for the Joint programme of
Master in Urban Climate & Sustainability

August 2021

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A Framework for Contextualizing Environmental Education Practice & Urban Green Management in Cities

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ABSTRACT

The worldwide Education system is going through continuous changes since evolution due to changes in strategies for survival. While the traditional idea of Education inclines towards indoor-based learning, the emerging stress on outdoor Education to connect students with local nature increases the potential of climate-responsive Education. Educating people to grow as 'environmentally aware citizens' can also boost their active participation and help cities grow sustainably. Different cities around the world (e.g., Lahti, Kyoto, Oki Islands, Glasgow) have adopted 'Outdoor Education' (OE) and 'Environmental Education' (EE) as tools for sustainable development in cities with the collaboration of local communities. However, the scope for outdoor Environmental Education can vary largely in different cities. The majority of cities worldwide are lagging in incorporating local green spaces purposefully, especially in densely built cities (e.g., Dhaka, Bangladesh).

Moreover, the multiple health benefits related to urban green areas, including enhancing local climate and reducing Attention-deficit hyperactivity disorder (ADHD) at an early age, have put more stress on green management in urban areas. This research focuses on reviewing the potential of Environmental Education Practice (EEP) as an Urban Green (UG) management tool in different cities. The study critically analyzes existing practices in other cities to understand EEP's socio-economic and environmental impact while exploring students' perceptions of the local environment. This analysis helps understand whether contextual differences, even within city-scale, can or cannot impact pro-environmental behaviours and willingness for outdoor Educational activities. Analyzing students' responses and contextual morphology of relative school neighbourhoods, one in densely built-up areas and one in greener areas in Lahti and Dhaka, helped identify critical urban built and natural indicators to develop the School Criticality Index (SCI). The proposed SCI helps distinguish schools based on their contextual differences within a city and suggests interventions related to greening within school neighbourhoods for optimized EEP. The proposed SCI can help researchers, practitioners, and policymakers identify factors affecting lesser or more EEP potential in different contexts, focus on where to increase greeneries, and integrate schools with Urban Green (UG) management through climate resilience Education.

Originality Statement

I hereby declare that this Master's dissertation is my own original work, does not contain other people's work without this being stated, cited and referenced, has not been submitted elsewhere in fulfilment of the requirements of this or any other award.

Shammi Akter Keya
August 2021

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ACKNOWLEDGMENT

First of all, I would like to thankfully acknowledge this fantastic opportunity of working and learning with the MUrCS Consortium. These two years of the ERASMUS+ Programme have been a life-changing experience for me. When I look back, I can see the journey itself has made a real difference in me growing as an individual and a professional.

My very heartfelt gratitude goes to Prof. Dr. Eeva Aarrevaara for her continuous support since the HYPE project and for encouraging the idea of Environmental Education Practice for urban environment enhancement. Without her encouragement, this study wouldn't have been possible. And, to Dr. Caroline Gallagher, I am grateful for her valuable guidance and support during this dissertation. Special thanks to Prof. Emmanuel Rohinton and Benjamin Fisher for their time and guidance.

Thanks to Emma and Alexandra for helping me connect with the the teachers and students from Tiirismaan Peruskoulu and Kukkasen Koulu schools in Lahti during COVID-19 complications. Many thanks to all the professionals from NatureScot for giving me their time for the interviews. To Mr. Mehedi and Mr. Rafi for their support in conducting the online surveys in Dhaka. To Mr. Lemon and Mr. Razi for helping me with data from BANBEIS and Dhaka City Corporation. Thanks to Henrik Sari for helping me with the Maptionnaire service by Lahti City. Special thanks to Paul Carroll for helping me with the linguistics support.

Thanks to all the MUrCSians, my dear friend Milagros and Oksana for being the family throughout this journey. Many thanks to Kiran for supporting me with his knowledge and insights during the study.

Finally, I am forever grateful to my dear parents, Mr. Osman Kabir and Sufia Begum, for their unconditional support. Also, to my siblings and friends back in Bangladesh for being there whenever I needed to talk to them during this time.

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ABBREVIATIONS

UNEP- United Nations Environment Programme
OE- Outdoor Education
OA- Outdoor Activity
EE- Environmental Education
EEP- Environmental Education Practice
OEA- Outdoor Educational Activities
UG- Urban Green
NDVI- Normalized Vegetation Index
MNDWI- Modified Normalized Difference Water Index
LST- Land Surface Temperature
NE- Natural Environment
UE- Urban Environment
PM10- Particulate Matter
TBC- Total Bacteria Count
OECD- Organisation for Economic Co-operation and Development
GEEP- Global Environmental Education Partnership
ADHD- Attention-deficit hyperactivity disorder
IPCC- Intergovernmental Panel on Climate Change
SCI- School Criticality Index
UGMF- Urban Green Management Framework

CHAPTER 1: **INTRODUCTION**

The history of humanity on earth carries evidence of venturesome adaptation with the change in geography, society, culture, economy. These changes happened gradually throughout the years while responding to climate change directly or indirectly. As stated by *Erik (2017)*, while the temperature on earth increased by 5 degrees Celsius over periods spanning some five thousand years starting from an ice age, recent studies show that temperatures will increase by 2 to 6 degrees by the next century. Now, cities play a critical role in climate change; as reported by UNEP 2018, urban areas are responsible for 70% of carbon dioxide (CO2) emissions and 60-80% of the total global energy if being consumed by cities through electricity and transport. Moreover, compact urban settings can alter humidity, airflows resulting in excess temperature gradients compared to the global scale as they have characteristics as more built area concentration, more surface roughness, and heat retention, lesser atmospheric dispersion, and ventilation in the street canyons *(Janković & Hebbert, 2012).* Therefore, it is needless to say that cities are facing effects of climate change as Urban Heat Island (UHI), already on so many aspects throughout the world. With this rapid urban climate change, the most relevant question is, are we or our future generation ready to tackle this? The answer might be hidden somewhere within the process that we are adapting to deal with the urban climate change and if the process towards adaptation is leading towards climate resilience.

Since evolution, Education has been the way of every human's tactic towards survival. It started from being educated in some survival skills that later turned into being capable of surviving in different contexts of different countries. The utmost concern here about the evolution of Education is, Formal Education has become "Indoor Based" when the concept of "Outdoor Learning" still only relates to exploring the wilderness. With the era of climate change, outdoor Education should have developed into a formal way of learning how to be resilient towards climate change through hands-on experience in nature as it is more effective than traditional classroom-based Education. Environmental Education (EE) practice with schools strongly aligns with outdoor-based learning since it promotes awareness of the environment through direct and indirect engagement with nature that increases nature connectedness and well-being amongst future citizens *(Pirchio et al., 2021; Preston, 2011).* This dissertation focuses on the potential effects of outdoor Environmental Education Practice (EEP) on health, well-being & urban climate at neighbourhood scale of schools.

1.1. Rationale

According to the statistics of UNESCO, the COVID-19 pandemic has disrupted the institutional activities of at least 1.5 billion students worldwide, that is, over 90% of the world's children. Transmission in the outdoors of Corona Virus is much less likely than indoors enclosed space, which stresses the necessity of adequate airflow and a healthy environment for children in the school environment, which also indicates the need of integrating outdoor areas for educational purposes. But this pandemic has shown the scarcity and necessity of accessible urban open space and school fields for Outdoor Education (OE) *(Bayulken et al., 2021).*

Research by *Yang et al. (2015)* showed that the surrounding environment of schools directly affects classroom indoor air quality. Specifically, Particle Matter (PM10) and Total Bacteria Count (TBC) highly correlate with existing roads and cross-ventilation at the urban elementary schools in Seoul, Korea, which shows that despite being indoor, the children are eventually exposed to the surrounding urban environmental stressors. Now, Urban Vegetation or Urban Green (UG) (e.g., parks, reserved natural parks, flower beds alongside streets, green playfields) has direct impact on enhancing air quality and health *(Hoyle, 2020; Fowler, 2002; Laia and Kontokostab, 2019).* Therefore, greening in school neighbourhoods can be stressed here to reduce the impact of environmental pollution on a school neighbourhood scale. Intersecting Environmental Education with preservation of Urban Green spaces and school neighbourhood greening offers excellent potential to add to children's health value and economic and social benefits to the local green areas. However, which parameters of the urban built environment can directly or indirectly affect the establishment of EEP needs further research.

The emergence of outdoor places as learning spaces has become even more crucial considering their impact on climate, social, and economic factors. However, most of the existing urban green spaces within the city do not have a deeper purpose than serving only environmental purposes. Therefore, the argument for more residential areas than green areas is winning this debate most of the time because of the 'Urban Densification' concept. The 'Urban Densification' promotes 'Compact Sustainable Cities' as it promotes mixed land use and the close juxtaposition of buildings, roads, and other infrastructures mainly to limit transport energy use and urban sprawl while limited space is left for urban greenery *(Wolsink 2016; Jenks, Burton, and Williams 1996).*

On average, students between the age of 7 to 14 in OECD countries spend around 6,898 hours of formal instruction inside classrooms. The age group of 12-15 years old spends more hours inside classrooms than the other age groups *(OECD, 2007).* The majority of intended hours of instruction are compulsory, and students spend most of their active daytime inside the school environment. Therefore, the school and surrounding environment potentially play the most influential role in students' health and well-being. Quality of school neighbourhood environment needs more attention in equal access to local green so that every child gets access to similar 'Green Time' and 'Green Space.' Multiple studies, including *Kuo et al. (2021)* and *Kuo et al. (2018b),* refer to tree cover on school grounds and greeneries within 250m buffer of schools having a significant impact on academic achievement compared to the overall greenness within 1000m buffer or neighbourhood scale. The outdoor activity experience strongly correlates with the frequency of visits researched by *Wolsink (2016).* However, the correlation between the students' willingness for outdoor activities, pro-environmental behaviour, and urban environmental quality needs further research. Therefore, the necessity for reinventing and reconnecting the students and locals with neighbourhood green has added another dimension of researching 'Greening' within 250m for EEP establishment.

Now, Finland has the least indoor classroom-based learning hours compared to the rest of the OECD countries and has been practicing Environmental Education by ensuring the implementation of the ecologically sustainable development perspective in Education through public sector action programs based on the 1992 Rio de Janeiro UN Conference on Environment and Development *(Rohweder, 2004; Hype interviews, Emma Marjamäki, 2020).* Lahti city, Finland, has received the status of European Green Capital 2021. Lahti City has been actively involved in EEP for over 15 years in association with environmental organizations, Geoparks, kindergartens, and schools. The city got UNICEF's Child-friendly City status in 2015 and 2018. That makes it a good case study for analyzing the current EEP and identifying if contextual differences of schools considering the urban environment and proximity to nature are impacting students' outdoor activities and nature connectedness.

The scenario for establishing EEP in densely populated cities like Dhaka, Bangladesh is far more crucial yet complicated considering classroom environment, classroom-oriented Education, lack of green schoolyards and playfields, and existing accessible local green areas for outdoor learning. While a healthy environment for children and liveability in cities are potent components to consider for planning, a decrease in child-friendly urban open space, including streets, has reduced the opportunity for developing social capital, as *Karsten (2011)* mentioned, which also suggests narrowing green space will have similar effects on the value of green space for the development of children and young adults *(Baran et al. 2014; Loukaitou-Sideris 2003; M. Wolsink, 2016).*

In this dissertation, the value of proximity to green space for outdoor Environmental Education and better nature connectedness is investigated by surveying two schools in Lahti and two schools in Dhaka, for both cases, one in a denser urban context compared to the other, to identify elements of the urban environment that can affect the establishment of EEP in cities and which elements can be directly intersected with the schools for better urban climate management within 250m buffer of schools.

1.2. Research Questions

The research questions are the followings:

- What are the similarities and differences between EEPs by different organizations or Environmental bodies and EEPs by schools?
- Which factors in the urban environment alongside green areas might affect optimum EEP by schools in different cities?
- How far can schools contribute towards local climate enhancement and better urban Green (UG) management?
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1.3. Aim and Objectives

Aim

The aim is to develop a contextual framework for EEP establishment in cities for Urban Green (UG) management and climate resilience Education.

Objectives

The objectives of this study are:

1. To review current EEPs by different organizations/bodies on Socioeconomic and environmental parameters of cities
2. To analyse current exposure of nature corresponding to the surroundings of schools in Dhaka compared to Lahti
3. Identify Urban Environment elements affecting outdoor educational activity amongst students from the EEP in selected Case Study Schools in Finland and Dhaka
4. To develop School criticality Index (SCI) as a tool to analyze the vulnerability of schools considering key urban environment indicators causing more/less nature connectedness in different contexts for optimizing EEP and ensuring 'Just environment' for all
5. To develop Urban Environment Improvement Framework using proposed SCI model

1.4. Scope of the Research

The scope of the research is to analyze the correlation between urban environment and OE activities by schools using online surveys and remote sensing data collection. The online survey results are based on online questionnaire responses, considering students aged 14-16 years old with higher digital media accessibility. Moreover, due to COVID-19 restrictions, in-person meeting with students was out of the scope of the research. Lahti has been considered a standard case of EE practicing case study city considering the background of existing EEP in collaboration with schools and the possibility of accessing the school educators and students through the environmental educator of Lahti, Emma Marjamäki.

Study schools in Dhaka have been selected considering ease of access through the educators and the school locations aligning with the dense urban Vs. suburb context. The proposed contextual SCI model has been tested only on Dhaka City to look for possibilities and barriers for future EEP establishment. Future SCI improvement proposals have been made only for selected two schools from Dhaka since the questionnaire survey data for student's willingness only reflects the students' views from selected schools.

CHAPTER 2: **LITERATURE REVIEW**

2.1. 'Nature Connection' for Health, Well-Being & Pro-Environmental Behaviour

There are multiple positive impacts of 'Nature-time' on health and well-being, specifically on the younger age group for nature exposure since it has a long-term effect. 'Screen Dependency Disorder' is a new challenge for child neurology considering the attentional problems, hyperactivity, anxiety disorders, and depression. Nature acts as a solution for children with Attention-deficit hyperactivity disorder (ADHD) (*Kaplan, 1995*). Two established theories: the person-environment interaction model (*Kaplan, 1983; Kaplan & Kaplan, 2009*) and Attention Restoration theory[1] (ART) (*Kaplan, 1995)*, explain the impact of nature connectedness on sensible attitude towards nature and how different natural settings can decrease stress and performance anxiety amongst individuals.

Components of a 'Restorative' environment according to the ART by Kaplan:

1. ***Being Away***: Includes natural settings such as the seaside, the mountains, lakes, streams, forests, and meadows are all examples of idyllic places for *'getting away'*. It is very uncommon to find in an urban context; however nearby '*nature*' can be used for *'being away'* (e.g., Parks, Open spaces).

2. ***Extent:*** Designed *'Trails'* and *'Pathways'* can give a sense of the different world, settings with historical artifacts, and miniaturization.

3. ***Fascination:*** Certain qualities of nature such as clouds, sunsets, snow patterns, the motion of the leaves in the breeze can trigger soft fascination.

4. ***Compatibility:*** As stated by Kaplan, many people might find working in a 'Natural setting' much easier than working in a more 'civilized' or 'urban' setting, even though usually they are more used to the latter *(Cawte, 1967; Sacks, 1987).*

'Nature-time' with individuals has a vice-versa impact on the participating person and the surrounding nature itself. This phenomenon can be explained more through the 'Person-Environment Interaction (PEI) Model' as shown in Figure 1:

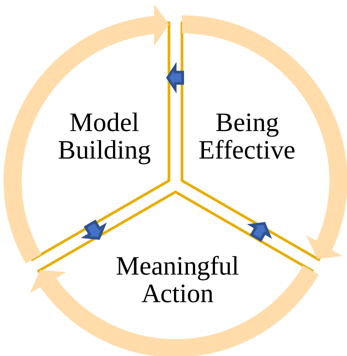

Figure 1 The Person-Environment Interaction (PEI) Model (Own adaptation from Kaplan (1983))

The 'Person-Environment Interaction' (PEI) Model explains the relationship between an individual's mental activity triggered by external and internal factors that indicate how

[1] Attention Restoration Theory
As Kaplan 1995 stated, humans' interaction with their surrounding environment indicates the significance of directed attention, and that is the crucial psychological resource needed for coping with challenges. However, directed attention held for a long time can cause fatigue, where natural settings can play a vital role in reducing stress and recovering attention capacity.

perception and reflection of the surrounding environment can affect an individual's real-life action towards the environment *(Kaplan, 1983) (Figure 2).*

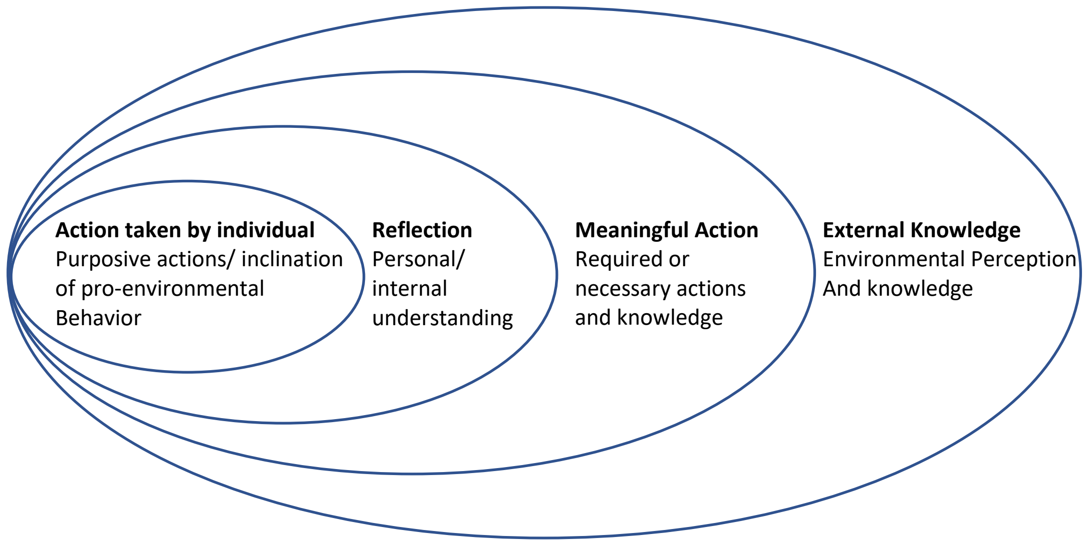

Figure 2 Ideal Scenario Causing 'Meaningful Action by Individuals' Towards Environment (Own adaptation from PEI Model and types of cognitive processes for PEI by Kaplan (1983)

It can be associated with one's sense of place gradually developed over time with real-time experiences there. Here 'Place'- as Alan Gussow stated in his *Artist-in-Residence for Mother Nature (1974)*, "is a piece of the whole environment which has been claimed by feelings.". Therefore, training the people to be sensitive and sustainable through their lifestyles towards the places they have the sense of belonging is easier. Several authors (*Gruenewald, 2003; Powers, 2004; Smith, 2002; Sobel, 2004; Woodhouse & Knapp, 2000*) acknowledge various other descriptive names to indicate the linking of local places to the formal educational process mentioned by *Gruenewald and Smith (2014).*

A sensible attitude towards earth starts with the appreciation of little things within one's surroundings. As literature-Nobel-laureate Rabindranath Tagore[2] wrote, *"I travelled miles, for many a year, / Spent riches, in lands afar, / I've gone to see the mountains, the oceans I've been to view. / But I haven't seen with these eyes/ What two steps from my home lies/ On a sheaf of paddy grain, a glistening drop of dew."* – (Collected from *Sphulinga*[3]). Knowing what's within the locality and how to interact allows individuals to act more sustainably towards nature.

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[2] The literature-Nobel-laureate Rabindranath Tagore was one of the most progressive educators of his time. He envisioned a holistic education that was deeply rooted in one's culture and surroundings and connected to the outside world. Tagore strongly believed that an ideal school should be amidst nature. He created Santiniketan (formal inauguration in 1921) (the first example of an environmental education facility in west India). His suggestions included that; lessons should take place mainly outside in the shade of trees. He recommended spending at least one school day outdoors for schools in less warm climates, not counting sports, games, and excursions. Source- The Scottish Centre of Tagore Studies, (2020)

3 *Sphulinga*- 1945 edition of Bengali poem anthology by Rabindranath Tagore

2.2. Rethinking Formal Education as Place-Conscious Pedagogy

From the dawn of human civilization on Earth, Education has been the way to make sure they survive. Initially, it was mainly about learning basic survival skills. Then it gradually became a tool to train people to serve consumerism sectors outlined for any specific culture. More specifically, the process through which children from different cultures learn how to survive in the physical and social realities in their respective cultures with the help of provided tools and knowledge is the ideological concept of Education as mentioned in the *EarthEd: Rethinking Education on a Changing Planet*, *(2017).*

Here, Erik Assadourian[4] explains the concept of intersecting Education for sustainability with Education for resilience which can result in Earth Education *(EarthEd, 2017)*. The root of this concept is to make the core of Education Earth-centred. As it states, 'Ideally, given the limited hours in the school day, curricula will need to be designed around lessons and projects that maximize both Education for sustainability and Education for resilience, whenever possible.' In other words, the idea of 'school-time' and infrastructure-oriented lessons needs to be changed. Here it is also explained that consumer culture-oriented Education has no sense of a sustainable lifestyle and is rapidly changing the Earth's systems to a threatening point, causing the uncertainty of the survival of countless species and human communities worldwide.

Systematic rethinking of Education here refers to the inclusion of Earth-centric Leadership, Deep Learning, Creativity, Interdependence, Earth-dependence as part of life skills. People need to realize that the Earth is going through rapid ecological changes. To survive here, they require efficiency and knowledge relevant to survival skills. As stated here, 'State of the World 2017 explores how Education, particularly Formal Education, will need many new educational priorities such as Eco literacy, moral Education, systems thinking, and critical thinking, to name a few.' *(Earth Ed, 2017)*

This new thinking of Education relating to the place can be a tool to develop an awareness of space and environment sensitivity amongst the students. *Gruenewald & Smith (2014)* stated in 'Place-Based Education in the Global Age' that, "Place-based Education is a broad term that not only refers to a method of teaching, but a growing movement to redefine schooling and a theory about how we should ultimately view Education. Therefore, developing one simple definition for this term proves difficult." In other words, this is solely not about restructuring schooling. The purpose is to learn about the whole system, including what to learn in this era of climate change, why, and how to manage this sustainably. Here, it is explained that place-conscious Education can enhance skills and dispositions amongst children and youth to regenerate and sustain communities.

[4] Erik Assadourian is a senior fellow at the World watch Institute and Director of State of the World 2017 and World watch's EarthEd Project.

2.3. Contextualizing Environmental Education for Effective Environmental Literacy

Though there has been an argument about assuming Environmental Education as the silver bullet to overcome unsustainable behaviour amongst the citizens, *Edsand and Broich (2018)* researched on finding out whether Environmental Education is directly associated with Environmental-Literacy[5], if yes or not- to what extent, also how much it varies for developed and developing countries. The study found statistics for the students aged 15 showing when environmental awareness is directly connected to Environmental Education while Renewable Energy Technology (RET) usage is not. Tung et al., (2002) has also supported the connection between EE and environmental literacy. It is also evident that the literature for individual and school-related environmental literacy for the developed world is prominent. While it is very uncommon in developing countries, it is crucial to understand the contextual factors to improve the Education structure in different countries. As stated by *Lin & Shi (2014, p. 74)*, "Understanding how certain student- and school-related factors can (or cannot) influence environmental literacy, both in the developed and developing world, can help to further improve educational policies, programs, and practices for sustainable development".

The prominence of contextuality can be connected to recognizing the importance of different places and cultures. In other words, 'either all places are holy, or none of them are. All places, in other words, are deserving of our attention, respect, and care.' *(Gruenewald & Smith, 2014; Jackson, 1994)*. Understanding the surroundings, nature, and traditional cultural practices- is the best way to create awareness of natural resources. The best way to know how to sustain within an environment is to learn how traditionally communities have survived historical environmental changes. Knowing the measures that worked effectively in any specific place and learning what other areas with similar ecological and cultural characteristics had done can be an efficient way to gather knowledge of being and possibilities.

Several authors have discussed the idea of 'commons' between human and non-human beings in a system for survival *(Gruenewald & Smith, 2014; Bowers, 2005). Bowers (2005)* described the idea of 'commons' is- 'those relationships and systems that contribute to the well-being of a community and that have not been commodified by the capitalist–industrial system. These include natural systems such as air, water, and forests; cultural systems such as public spaces and the legal protections that keep them public; and civic associations found in mentoring and intergenerational relationships. Through Education in a place that connects teachers and learners to the life of the wider community, these ecological and cultural commons must be identified, conserved, and restored.'

[5] In 'The Impact of Environmental Education on Environmental and Renewable Energy Technology Awareness: Empirical Evidence from Colombia' by *Edsand and Broich (2018)*, it has been assumed that Environmental Literacy consists of five components: (i) environmental awareness, (ii) awareness of RETs, (iii) responsibility for sustainable development, (iv) environmental optimism, and (v) perception of environmental issues.

The 1978 final report of the Tbilisi conference describes the role of Environmental Education- 'to enable individuals of all ages and from all backgrounds, to assimilate the values, the basic concepts and the practical knowledge which will help them to an awareness of environmental problems, help them to adapt their everyday behaviour accordingly and thus make a useful contribution to the joint effort to safeguard the environment *(UNESCO, 1978, p. 67).* Thus, the linkage between place consciousness and Education can create efficient environmental literacy to thrive as a sustainable world. In other words, rooted experience has spatial and temporal dimensions; therefore, place-consciousness must also include the consciousness of the historical memory of a place and the traditions that emerged there, whether these have been disrupted or conserved- as stated by *Gruenewald and Smith (2014).*

2.4. Linkage Between Environmental Education and Urban Green Preservation

Environmental Education and Formal Education have a very defined division that shows the inadequacy of the traditional Education system to provide for future human welfare. 'The process of Formal Education in schools and universities is often totally isolated from the immediate context of community life.' *(Gruenewald & Smith, 2014)*. It explains the prominent distance between what is being taught and what is required to be taught. The requirement for following international standards without comparing the contextual factors could be the reason behind this. Outdoor Education can be regarded as a practical form of Environmental Education since its beginning. It has a lot more potential to serve sustainable development.

There has always been this debate while urban development between urban green preservation or transforming open spaces into a built area. Most of the time, the argument for built area extension replacing green spaces is winning since it has evident Economic and Social benefits *(Wolsink, 2016; Jabareen, 2006; Ruming et al., 2012).* However, the factor of environmental impact gets whitewashed because of the other two. While the urban green areas mostly do not have economic and social factors other than mainly for recreational purposes. Also, green spaces might suffer from low maintenance that doesn't have meanings other than only recreational and place for human interactions. which can lead to more environmental problems.

Conversely, quality greenspaces attract more significant numbers of people who are likely to undertake physical activity within the green space and enjoy opportunities for social contact *(Barker et al., 2017; Brindley et al., 2019).* As mentioned by the author, multiple researchers have recognized this factor of 'Quality' of green spaces over 'Quantity', having an essential role in health and educational performance *(Akpinar, 2016; Akpinar et al., 2016; De Vries et al., 2003; Maas et al., 2006; Ord et al., 2013; Richardson et al., 2010; Richardson and Mitchell, 2010; van den Berg et al., 2007; Vujcic et al., 2018; Wyles et al., 2019).* The relation between educational performance and quality of green indicates the importance of well-maintained urban green spaces. Therefore, intersecting outdoor Environmental Education with existing urban green areas can potentially preserve urban green effectively.

According to UNICEF report, the Covid-19 pandemic has resulted in educational disruption for more than 214 million students worldwide since March 2020 (source: https://www.unicef.org/). The idea of indoor classroom-based Education has been shaken to the core since most educational institutions worldwide have had to be closed since the beginning of 2020 *(Figure 3)*. Conversion of Education to online media created a digital barrier amongst students, especially in the marginal countries with poor or no access to the internet. Utilizing outdoor spaces for decreasing screen time hasn't been an easy option either since the traditional way is classroom-based. It requires equal accessibility to nearby open areas and necessary infrastructures and support for the schools.

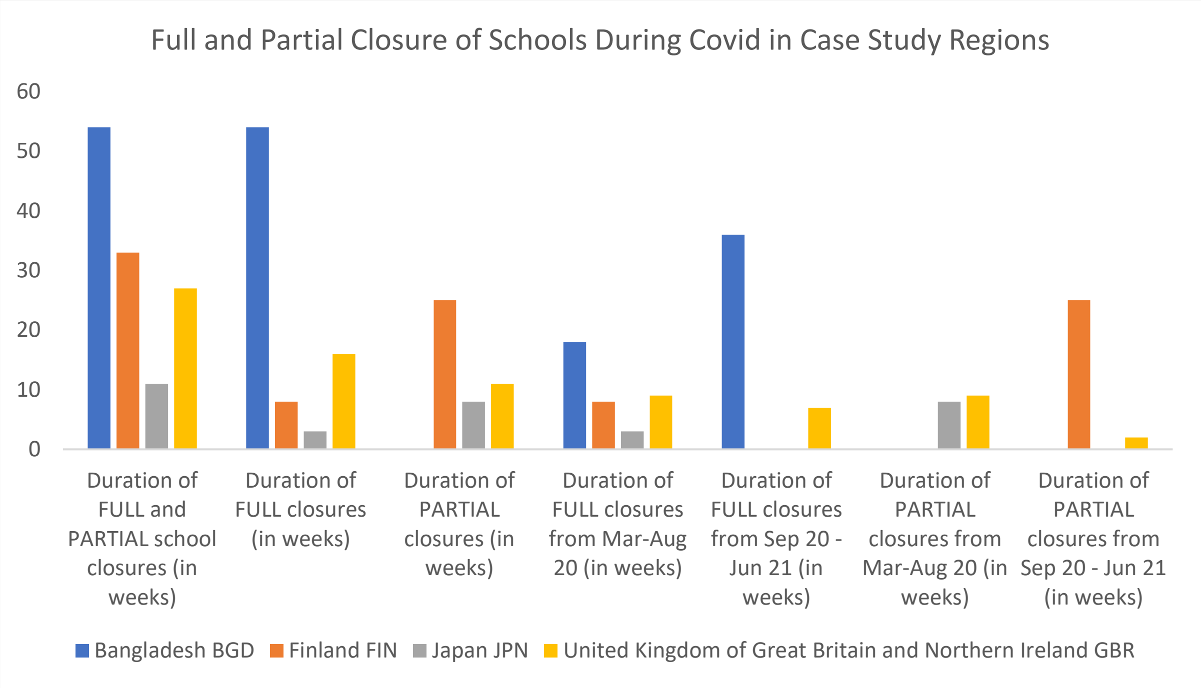

Figure 3 UNESCO global dataset on the duration of school closures, Full closure: Closed at the nation-wide level due to COVID-19, Partial closure: Closed in some regions or for some grades, or with reduced in-person instruction. (source:[https://en.unesco.org/covid19/Educationresponse)](https://en.unesco.org/covid19/Educationresponse)

The pandemic threatens the survival of organizations nationwide that provide critical outdoor environmental and science Education to K-12 students, with an alarming 63% of such groups uncertain about their ability to ever reopen their doors, according to a study released by the Lawrence Hall of Science at the University of California, Berkeley *(Sanders, 2021)*. This also indicates that both infrastructure-oriented Education and the current Outdoor Education system need restructuring to be better resilient for the future. Considering the Covid-19 situation, while getting affected by the Coronavirus is less likely outdoor than indoor, the major problem is finding adequate green spaces in local areas. The pandemic has highlighted the scarcity of accessible green spaces in urban areas. The connection between the existing schools and adjacent green areas within communities can ensure more accessible green areas within cities for sustainable urban development and better protect the environment through Environmental Education.

2.5. Environmental Education Practices for Climate Resilience Education & Urban Green Management

Cities with Geoparks or Environment Protection Agencies have the common interest of protecting the local green areas and association with schools for Environmental Education to promote environmental awareness amongst the local people. As a result, different cities worldwide have adopted EEP as a tool for promoting sustainable development through community engagement and achieving UN Sustainable Development Goals.

Figure 4 Nine countries with National Policies that includes Environmental Education (Brazil, Finland, France, Ghana, Japan, Philippines, Republic of Korea, Taiwan and United States. (Source: Countries | Global Environmental Education Partnership (GEEP), 2021)

The new target set by UNESCO to make 'Environmental Education a core curriculum component in all the countries by 2025' shows the emerging stress on Environmental Education to promote sustainable behaviour amongst people around the world. This target includes curricular reformation and progress support for the 193 member states to improve skills, knowledge, values, and attributes to introduce positive change and climate change resilience development. The area of focus is the 'Transformation of Education'; including around 2,500 participants, including 81 Education ministers and leading players, to educate people about the climate crisis, biodiversity loss, and all other Sustainable Development (SD) challenges to help create strategies and framework for integration of EE with SD. *(UNESCO, 2021)*

Different initiatives such as Global Environmental Education Partnership (GEEP), UNESCO Global Geoparks, Environmental Agencies (*e.g., Salpausselkä Geopark, Lahti, Finland; Oki Islands Geopark, Japan*) and Nature protection bodies (*e.g., NatureScot (NS), Glasgow,* *Scotland and Miyako Ecology Center, Kyoto, Japan*) are stressing on EEP as a tool to protect nature in collaboration with the community people and educational institutions. These cities have effectively incorporated EEP as a tool to promote environmental awareness and outdoor learning. However, the inclusion of a bottom-up approach for effective EEP and involvement of citizens in urban environment improvement has different degrees in different cities.

Finland is one of the leading countries for Outdoor Learning. The strategic intervention of climate change resilience in cities preserving and managing existing green spaces in urban areas strongly aligns with the EEP by the Geoparks. Lahti city has multiple organizations (Geopark, Green Flag Schools, national nature and Environmental Education LYKE network) that engage in Environmental Education for UG management and environmental awareness.

Environmental Education has been practiced both as cultural & Educational background to develop individuals compatible with sustainability goals in Japan. According to the Japanese Ministry of Education around the 1990s, Environmental Education means knowledge that addresses global environmental issues and possible solutions. The later addition of the Teacher's Guide by the Ministry of Education described balanced environmental, economic, social, and cultural development *(Kodama, 2017).*

NatureScot has been promoting outdoor environmental learning in collaboration with schools to address climatic issues and incorporate GI-based learning in the city, considering the Scottish Index of Multiple Deprivation (SIMD). The analysis *by Majekodunmi, Emmanuel and Jafry, (2020)* in Glasgow shows, Green Infrastructure (GI) deprived areas tend to suffer more in Heat Wave and Flood incidents.

Different strategies adopted by other cities indicate that, despite the contextual differences in challenges and approach, the inclusion of EEP for achieving sustainable urban community development is common in all these cities. However, to what extent and how schools could be the central focus for sustainable development through EEP needs further research.

CHAPTER 3: **METHODOLOGY**

The study has been conducted in multiple phases that included both inductive and deductive approaches. The qualitative study considers an inductive approach through online questionnaires with the students of selected age group to through case study based approach combined with multiple online and in-person interviews with Environmental Educators, concerned authorities of EE practicing bodies in different cities, site surveys, official data, and remote sensing data for environmental parameters calculation.

The basic structure for addressing the three research questions is as follows: (Table 1)

Research Questions	Methods Adopted
Q.1 What are the similarities and differences in current EEPs undertaken by different institutions? (*Objective 1*)	Induction method • *Qualitative data* collection through literature review and open-ended interview responses • Analyzing collected data to find out similarities and dissimilarities
Q.2 Which urban environment indicators potentially affect the EEPs by schools in different cities? (*Objective 2 and 3*)	Deduction method • Critically analyzing selected cities with and without EEP practices (Lahti & Dhaka) in the light of urban built and natural environment considering exposure to nature in general in the existing urban setup (*Quantitative data*) Induction method • Pre-specified questions for current outdoor activity satisfaction and willingness analysis (*Qualitative and Quantitative data*) • Open-ended questions to identify key environmental factors correlated with outdoor activities mentioned by students (*Qualitative and Quantitative data*)
Q.3 How can schools contribute towards local climate enhancement and better UG management (*Objective 4 and 5*)	Deduction method • Analyzing identified environmental parameters in the selected city (Dhaka) for EEP establishment potential using proposed SCI Model • Recommendation for SCI improvement for EEP establishment framework in selected schools

Table 1 Outline of methods to address the research questions and objectives

3.1. Critical Review of Current EEPs in Different Cities

Literature review and case studies for identifying EE Activities and association with urban climate management in different cities to have a better insight of the current practices and to what extent cities are incorporating outdoor Education for health, well-being, and sustainable development in the local context. (Figure 5)

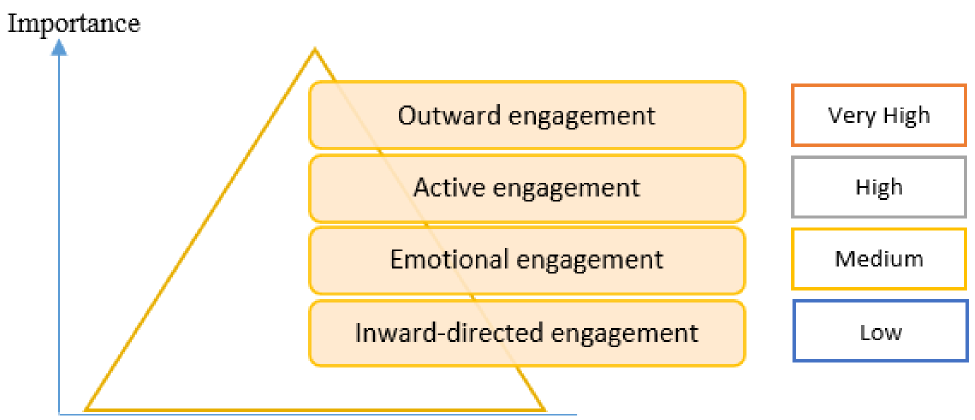

Figure 5 Ranking structure of 'EEP for well-being' inspired from the 'Reasonable Person Model' by Kaplan (1983) and 'Triangle of supporting environments' by Bengtsson & Grahn (2014)

Data Collection

Primary data has been collected through multiple online interviews with concerned authorities from Salpausselkä Aspiring Global Geopark, Kanerva Kindergarten (Lahti, Finland), Oki Islands UNESCO Global Geopark, and Miyako Ecology Center (Japan) and Environmental agencies such as NatureScot (Glasgow, Scotland). Pre-determined questions with probing have been used for the data collection (see Annex 01). Secondary Data has been collected from literature review and online survey data from Lahti City Maptionnaire based questionnaire conducted in 2017, NatureScot official website.

Analysis Method

The current activities by the concerned organizations have been grouped into an Environmental, Educational, and Socio-economic parameters to identify commonalities and differences with the activities conducted by the schools in Lahti, Finland.

3.2. Analysis of Existing Exposure to Nature

To analyse current exposure of nature corresponding to the surroundings of schools in Dhaka compared to Lahti. (Figure 6)

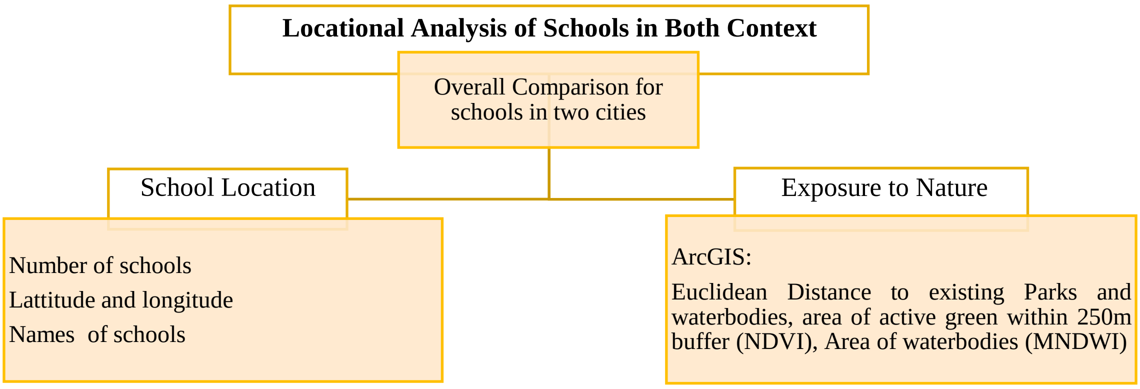

Figure 6 Analysis method of exposure to 'overall nature' considering 31 schools in Lahti and 324 schools in Dhaka for comparison between two cities

Data Collection

The schools, parks, and open-space location details data have been collected from the Bangladesh Bureau of Educational Information and Statistics (BANBEIS) and Dhaka South City Corporation (DSCC) for Dhaka. For data in Lahti, open-source data from Geofabrik.de, StatisticsFinland, and Maptionnaire services have been used.

Analysis Method

Based on the findings from the literature review, 250m buffer from the school locations has been taken in both cities (Lahti as the EE practicing City and Dhaka as the outdoor EEP establishment city) to compare the current distribution of UG and Blue infrastructures. Normalized Vegetation Index (NDVI)[6] has been used for calculating the existing amount of green in both cities. Band 8 containing near-infrared (NIR) and Band 4 containing red (R) from Sentinel 2A[7] (March 2020, Dhaka and July 2020, Lahti) have been considered for calculating NDVI since it is the summer period for both cities. For waterbody area calculation, Modified Normalized Difference Water Index (MNDWI)[8] considering Short-wave infrared (SWIR 2, Band 12) and Green (Band 3) values have been used. Location of schools and existing parks/ forests/ preserved green areas/ playfields have been derived from open-source data and Dhaka South City Corporation (DSCC).

The range of NDVI value was derived using training samples located in different types of vegetated areas such as dense vegetation, sparse vegetation, waterbody side vegetation, densely populated urban area vegetation identified in Google Earth Pro. The threshold for overall greenness area within 250m buffer of schools has been calculated using the observed minimum NDVI (0.45397) value from the zonal statistics of the training samples. For validating potential parks with standard NDVI for outdoor activities in Dhaka, the range has been derived from the zonal statistics of the green areas currently in use by the schools for outdoor learning in Lahti using Maptionnaire based questionnaire data from the 2017 survey. The threshold has been taken from considering 2SD from the mean NDVI of 0.63 with a standard deviation of 0.09. A resultant NDVI of 0.45 validates the NDVI threshold derived using training site samples in Dhaka.

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[6] 'NDVI is used to quantify vegetation greenness and is useful in understanding vegetation density and assessing changes in plant health. NDVI is calculated as a ratio between the red (R) and near-infrared (NIR) values as shown in the equation:

NDVI= (NIR - R) / (NIR + R) (Source: usgs.gov)

[7] Sentinel 2A and Sentinel 2B are two satellites from the Sentinel 2 mission. 'The European Space Agency's Multispectral Instrument on the Sentinel-2 satellite provides global (from 83 degrees north 56 degrees south latitude) 10-meter resolution, multispectral images every 10 days (2015-present). The Sentinel-2 mission consists of two satellites developed to support vegetation, land cover, and environmental monitoring.' (Source: usgs.gov)

[8] "The Modified Normalized Difference Water Index (MNDWI) uses green and SWIR bands for the enhancement of open water features. It also diminishes built-up area features that are often correlated with open water in other indices."

MNDWI = (Green - SWIR) / (Green + SWIR) (source- https://www.space4water.org/)

3.3. Student's Response & Urban Environmental Stressors Analysis

To identify Urban Environment elements that might be affecting the Outdoor Educational activity and more or less willingness for OE activities amongst students from selected Finnish Case studies and identified Schools in Dhaka (Figure 7)

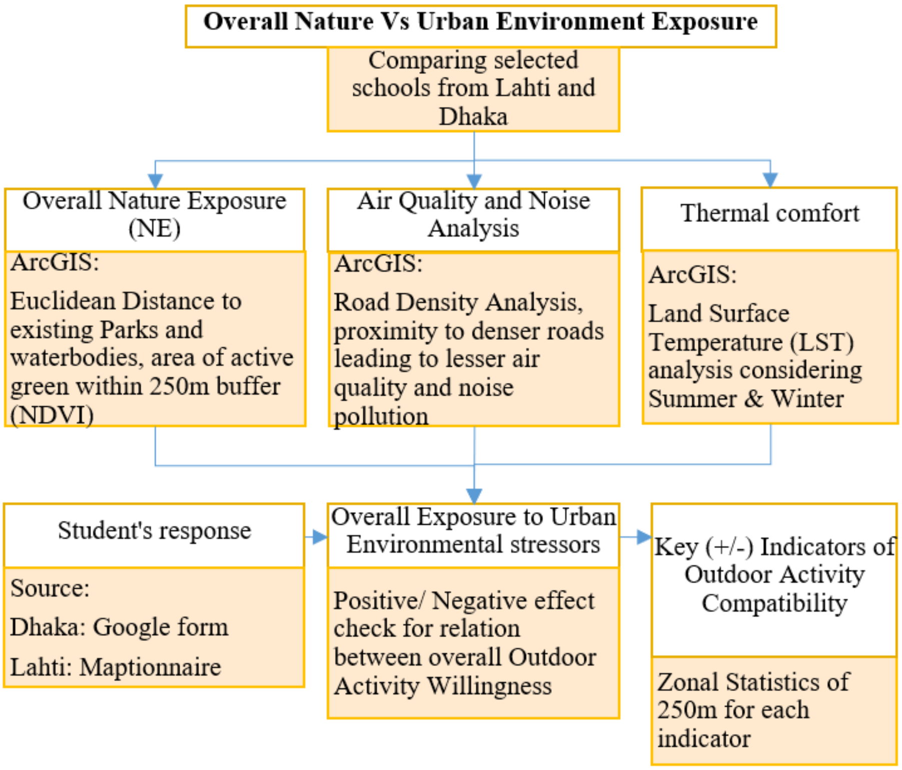

Figure 7 Identification method of crucial urban environmental stressors using students' responses and contextual analysis

Data Collection

Google form and Maptionnaire based questionnaire have been used for collecting students' responses from two schools in Dhaka and two schools in Lahti, respectively.

Analysis Method

In both cases, the student's responses have been grouped based on three main categories: 1) Current Outdoor Activity, 2) Problems Identified, 3) Satisfaction and Willingness. From the findings of identified problems related to the urban environment affecting outdoor activity or pro-environmental behavior, the overall amount of existing nature and exposure to the urban environment (thermal comfort and road density analysis) have been compared with the student's responses for validating the impact of urban environment and proximity to nature for EEP establishment. Indicators causing more willingness have been categorized as Adaptive Capacity, while indicators causing less willingness or complaints about outdoor activities have been considered indicators of urban stressors exposure and sensitivity to develop the SCI model in Objective 04.

3.4. School Neighbourhood Criticality Identification

3.4.1. Developing School Criticality Index (SCI)

EEP establishment potential of the schools selected city (Dhaka) has been evaluated based on the vulnerability assessment for outdoor activities. The criticality assessment of schools for outdoor activities indicates the potential for more or less active engagement with nature and how many schools may need vital interventions as- GI development within the neighbourhood for establishing EEP in the city.

The central concept of the criticality assessment of the schools is based on the understanding of the 'internal and external aspects of vulnerability' explained by *Chanbers, R, (1989).* Here, External aspects indicate the intensity of the experience (depends on geographical location), and internal aspects indicate the ability to recover specific incidents (depends on access to resources). Multiple other researchers have also considered external and internal aspects to assess criticality of a place or system.

The indicators for the criticality of schools have been developed based on the function of three factors as defined by the Intergovernmental Panel on Climate Change (IPCC) *(own adaptation from three factors mentioned by IPCC, 2007; Hahn et al., 2009; Madhuri et al., 2014; Mohan & Sinha, 2011)*

The types and magnitude of exposure of the target system can be grouped into three main components:

1. Adaptive capacity
2. Zonal sensitivity &
3. Exposure

Selected indicators for calculating School Criticality Index (SCI) (Figure 8)

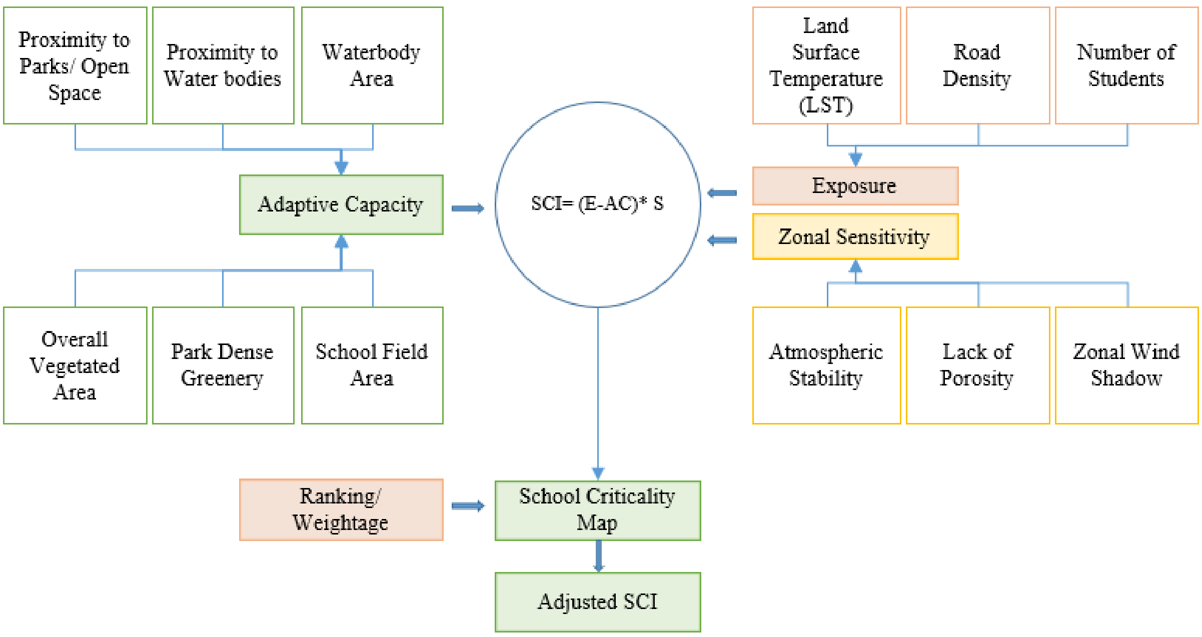

Figure 8 School Criticality Index (SCI) Model with simple average of components and weighted averaged SCI

School neighbourhoods needing more greening and infrastructure improvement for EEP establishment have been assessed using identified indicators. The criticality assessment model called School Criticality Index (SCI) is developed following equation (1) shown below:

$$\text{SCI}, \quad \boldsymbol{I_{SC}} = (Exposure, \boldsymbol{I_E} - Adaptive\ capacity, \boldsymbol{I_{AC}}) \times \text{Sensitivity}, \boldsymbol{I_S} \tag{1}$$

For normalizing the selected indicators, following equation (2) has been used,

$$\text{Indicator Index}, \boldsymbol{I_x} = \frac{\boldsymbol{I_d} - \boldsymbol{I}_{(\mathbf{min})}}{\boldsymbol{I}_{(\mathbf{max})} - \boldsymbol{I}_{(\mathbf{min})}} \tag{2}$$

1. Adaptive Capacity

For Dhaka, considering the less potential of accessible parks or open areas from the majority of the selected schools, the school field has been added as a contextual indicator for potential outdoor activity areas. In addition, zonal statistics for the 250m buffer of the two selected schools have been derived for calculating the simple averaged 'Adaptive Capacity.

The overall exposure to nature from school locations and 250m buffer neighborhood scale has been calculated following simple average as equation (3):

$$\boldsymbol{N_{ex}} = \sum_{\boldsymbol{i=1}}^{\boldsymbol{i=n}} \boldsymbol{I_n} \tag{3}$$

Here, n = Number of Indicators Considered

Methods calculating 'exposure to nature' as mentioned in objective 02 and 03 methodology has been considered for calculating Adaptive Capacity (e.g., Euclidean distance, NDVI, MNDWI calculation and zonal statistics in ArcGIS).

2. Exposure

Exposure indicates the external factors to which a system is susceptible to and unable to cope; here, outdoor activities are vulnerable to thermal comfort, air pollution, noise, road safety, the scale of the population exposed in the system.

i) Land Surface Temperature (LST) has been calculated using LANDSAT 8 thermal infrared sensor Band 10 data following the method explained by Mustafa et al. (2019). Here, considerations are only for a selected hot summer day in Dhaka and both winter and summer days in Lahti based on the findings from students' responses. Here, LST for throughout the year hasn't been calculated, only available days from the hottest summer months from Glovis.USGS platform (27 March 2020 for Dhaka and 14 June 2020 for Lahti) and open data for winter (22 March 2020 for Lahti) have been considered. Cloud cover less than 5% has been considered to avoid cloud and cloud shadow pixels for more accuracy in LST calculation.

ii) **Road Density** has been calculated by assigning values of 0 to 5 based on the ranking of five categories of roads to identify nodes with higher concentrations of heavy traffic roads, indicating association with poor air quality and noise pollution. (Table 2) (See Annes 06)

Trunk road	5
Primary road	4
Secondary road	3
Tertiary road	2
Residential road	1
Pedestrian way	0

Table 2 Weightage of 5>0 assigned to different categories of roads based on ranking of 'heavy' to 'light' motored vehicle passage

iii) **The number of students** has been considered as an indicator of the scale of exposure considering adolescents.

3. Zonal Sensitivity

Zonal Sensitivity indicates the internal qualities of the urban setup to explain contextual sensitivity for outdoor EEPs. For Dhaka, based on the findings from objectives 2 and 3, lack of ventilation and visibility of existing greens due to congested urban built-up has been considered as zonal sensitivity stressors.

i) **Atmospheric Stability** refers to lack of wind turbulence indicating lack of ventilation and less 'downward draft' of wind which is the reason for more turbulence, therefore more wind flow. Therefore, 'lack of variation' in the 'effective wind flow height' indicates lesser dispersion of heat, air pollutants, dust and leading to less thermal comfort and air quality *(Guo et al., 2020).*

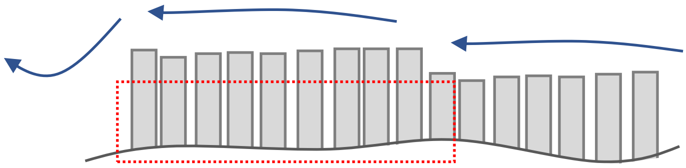

Figure 9 Lack of variation in Effective Wind flow with less downward draft inside urban canyons and equal building height area

Here, variability in building heights indicates more variation in effective wind flow height, therefore more turbulence and ventilation *(Figure 9).* It has been calculated using mean effective airflow height and standard deviation of effective airflow height within 300m buffer.

Co-efficient of variation, CV = STD of Air Flow Height / Mean Effective Air Flow Height
Therefore, Lack of turbulence or lack of CV = 1- CV

ii) **Zonal Wind Shadow** has been calculated from wind effect analysis and zonal statistics of 300m buffer. The values from wind effect have been inverted to derive fraction of areas deprived of wind access.

'Wind effect' explains topological impact on complex air flow in urban context as it considers 'relevant surface properties, such as the meteorological roughness and vegetation/land cover' *(Boehner & Antonic, 2009).* The values of wind effect are dimensionless and the fractions of wind exposed areas are derived by taking values above 1, while values below 1 indicates wind shadow areas. The DSM Elevation data along with the annual Mean wind direction of 185.5 degrees angular to the north have been considered for the analysis leading to direct wind effect index as resultant. (See Annex 4 & 5)

SAGA GIS has been used for effective airflow height and wind effect analysis considering average wind speed of 2.7 kph.

iii) Lack of Porosity is associated with the volumetric density of the neighbourhood. The concept of porosity indicates the volume ratio excluding buildings. Therefore, it can be related to the openness or volumetric density of the neighbourhood buildings *(Park et al., 2017; Gál & Unger, 2009) (Figure 10).*

$V_{b_i}: volumn\ of\ building\ (i);\ i: number\ of\ buildings$

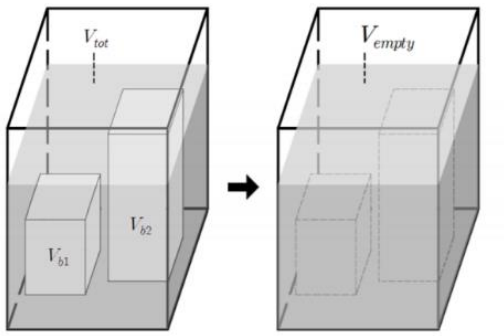

Figure 10 Volumetric porosity concept by Park et al., 2017

First, porosity has been calculated using following equation (4) as stated by Park et al., 2017

$$R_{porosity} = \frac{V_{total} - \sum V_{b_i}}{V_{total}} = \frac{V_{empty}}{V_{total}} \quad (4)$$

First, the value has been normalized ranging from -1 to 1, then the normalized value has been inversed to derive the lack of porosity.

$$\text{Normalized Porosity}, R_{porosity_X} = \frac{R_{porosity_d} - R_{porosity_{min}}}{R_{porosity_{max}} - R_{porosity_{min}}} \quad (5)$$

$$\text{Lack of porosity or volumetric density}, \ P_L = 1 - R_{porosity_X} \quad (6)$$

Here, the lack of porosity has been considered an urban environment stressor as it indicates volumetric density and lack of ventilation leading to less dispersion of pollutants.

3.5. Urban Green Management Framework Development

The Urban Green Management Framework (UGMF) for EEP establishment in cities considers the average SCI score for zonal classification, and adjusted SCI scores are considered for school-specific interventions. (Figure 11)

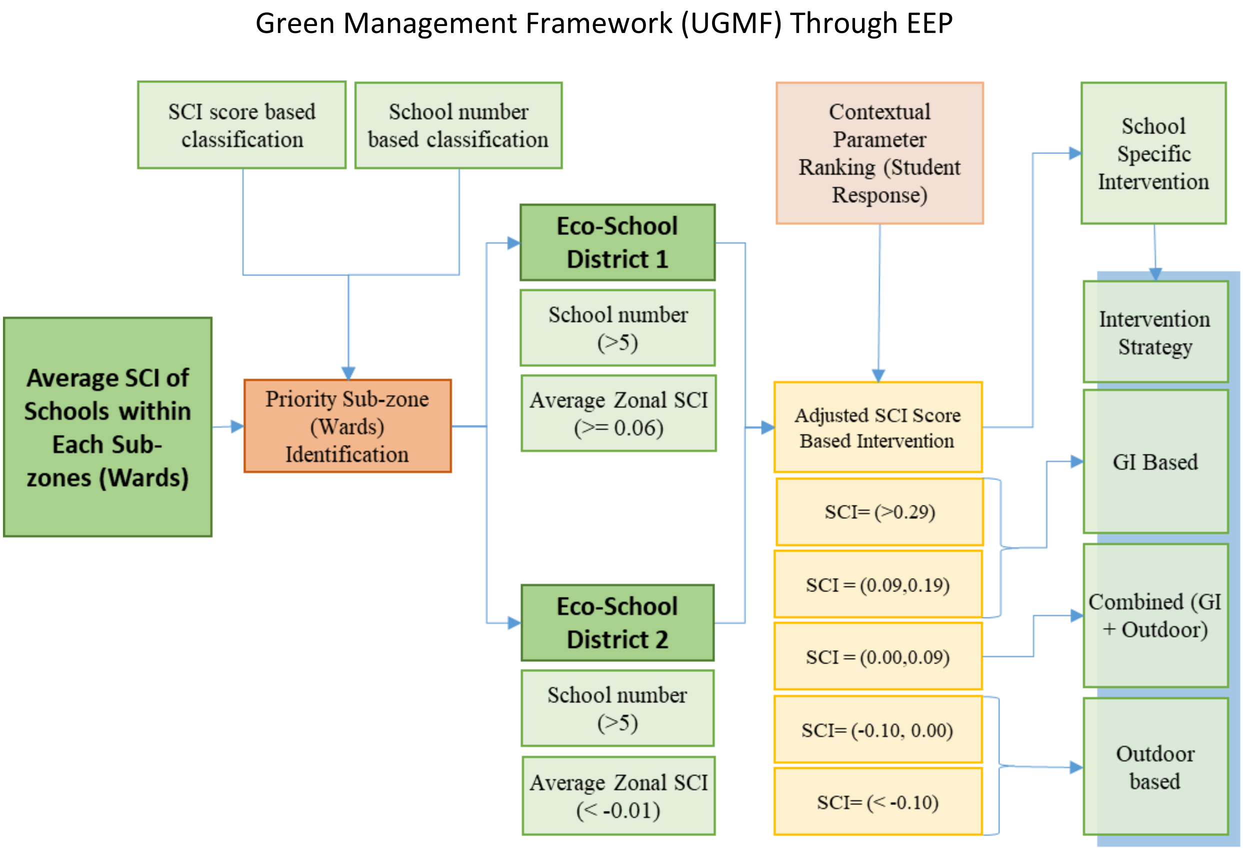

Figure 11 Proposed Urban Green Management Framework (UGMF) for EEP establishment in cities

The SCI score-based UGMF illustrates the decision-making steps for macro scale zone selection and microscale (school-specific) intervention strategy to help identify which areas are falling under the same sort of EEP category. The proposed UGMF considers the quantile classification of schools numbers and Mean SCI scores to classify wards percentile categories. Five classes have been considered for each categorization and the resultant wards with high and low criticality contain schools with 80th percentile of high SCI and 80th percentile of low SCI scores respectively.

CHAPTER 4: RESULTS AND DISCUSSIONS

The results have been divided in five sections according to the objectives.

1. To review current EEPs by different organizations/bodies on Socioeconomic and environmental parameters of cities
2. To analyse EEP establishment potential of Schools in Dhaka compared to Lahti considering proximity to green
3. Identify Urban Environment elements affecting Outdoor Educational activity amongst students from the EEP in selected Case Study Schools in Finland and Dhaka
4. To develop School Criticality Index (SCI) as a tool to analyze vulnerability of schools considering key urban environment indicators causing more/less nature connectedness in different contexts for optimizing EEP and ensuring 'Just environment' for all
5. To develop Urban Environment Improvement Framework using proposed SCI model

4.1. Section 1

4.1.1 Critical review of current EEPs by different organizations/bodies

Different environmental organizations involving EEP to revive environmental awareness and climate resilience with community collaboration have been studied. The analysis adds to the understanding of the current activities and to what extent the schools can be potential participants of EEP for sustainable development.

EEP by Geoparks

'A geopark is a unified area that advances the protection and use of geological heritage in a sustainable way, and promotes the economic well-being of the people who live there.' *(Keever & Zouros 2005; Zouros 2004).* 'The official label of UNESCO Global Geopark (UGGp) was created in 2015 and UGGps are strategic tools for territorial development with medium- to long-term results' - as stated by *Henriques and Brilha, 2017*. The three essential services of Geoparks are: a) Geo-conservation, b) Education and c) Eco-tourism. As stated by *Catana et al., (2011),* Environmental Education and 'Education for Sustainability have been set as the core for Educational programs and activities in a Geopark. *(Canesin et al., 2018).*

The usage of EEP by the Geoparks can be categorized into three primary parameters:

1. Environmental 2) Educational and 3) Socio-Economic

1) ENVIRONMENTAL

i) Connection with Nature

The Geoparks are promoting environmental awareness through direct and indirect involvement of the local community people with nearby nature. The activities support guided tours for the tourists, students, and local people who often take part as nature guides. Geoparks also promote connecting with schools as an active tool to involve community people with local nature, to educate them how to protect and co-live with local nature.

ii) Monitoring Nature

In the Salpausselkä Geopark day-care center, every child gets close to nature at least once a week. The kindergarten is committed to increasing the use of nearby nature as a learning environment. Different environmental activities such as monitoring the cycle of seasons, learning about different water states, plant species, geology, and ecology, are conducted in nearby nature. Environmental Education activities are also regularly documented. *(Hype interviews, Emma Marjamäki, 2020)*

iii) Waste management

Geoparks support waste management activities such as reducing plastic waste in outdoor areas, litter picking, cooking programs to reduce food waste, and separating domestic wastes.

iv) Native plant species protection

Both Salpausselkä and Oki Islands Geoparks are actively involved in native plant species protection to protect the local biodiversity.

v) Recycling

Geoparks promote recycling through the active participation of local people and school-going children.

vi) Learning About Surrounding Environment & Culture

Geoparks actively promote connecting with museums, local libraries, nurseries, kindergartens to teach the small children about three main topics: a) Geological heritage of the place, b) Environmental pollution and protection, c) Awareness of local materials and products. *(Hype interviews, Emma Marjamäki, 2020)*

2) EDUCATIONAL

i) *Including Students in Environmental Management*

Geoparks support school students' involvement in environmental protection activities such as recycling (e.g., sharing toys), green area and forest mapping, route drawing for outdoor activities, etc. In addition, Salpausselkä Geopark incorporates students in exotic plant species removal as part of their outdoor activity time in nature. *(Hype interviews, Emma Marjamäki, 2020)*

ii) *Involvement Through Online Platforms*

Moreover, the Geoparks are promoting student involvement through online platforms (e.g., Maptionnaire, Lahti, Finland) for involving them in decision-making about the conservation of green areas in use for outdoor learning. *(Canesin et al., 2018; Hype interviews, Emma Marjamäki, 2020)*

iii) *Involving Day-Care Centers for Early Childhood EE*

Kanerva day-care center has been involved in the project from the beginning and has been working together to build a criterion for the official" Geopark Early Childhood Education Center. (*Hype Interviews, Josefiina Marola, Kanerva Kindergarten, 2020).* Kanerva day-care center is nominated to be the first officially registered Geopark day-care center in Finland.

3) SOCIO-ECONOMIC

i) Human Resources Development

The human resources development activity includes providing an 'environmental educator' or 'trainer' system for guiding the schools and local community groups. The Geoparks have allocated budgets for paying the fee to the environmental educators of the regions. *(Hype interviews, Emma Marjamäki, 2020; Canesin et al., 2018)*

ii) Supporting Research and Stakeholders

The Geopark committees support research activities and the writing of research papers yearly. The budget is for scientists or students who plan to research and write scientific articles related to the Geoparks. In addition, the Geoparks are involved with the local museums for promoting awareness and turning the territories into learning laboratories. *(Hype interviews, Emma Marjamäki, 2020; Canesin et al., 2018)*

EEP by Environmental Bodies or Organizations

The findings for EEP practices in studied organizations are as follows:

1) ENVIRONMENTAL

i) *Connection with Nature*

NatureScot has been supporting outdoor learning (OL) in nature to enhance connection with nature & care for nature. They are also encouraging sustainable approaches to OL by encouraging learning on the doorstep of schools in their local greenspace, within walking distance, therefore, supporting active travel with no carbon footprint. *(Personal communication, Penny Martin, NatureScot, 2021)*

ii) *Waste Management Strategy*

Educating people about 'waste management' through both active and passive strategies is practiced in the Miyako ecology center, Kyoto, Japan. For instance, cooking classes showing how to prepare and cook while producing minimum waste, displaying money wasted to process unsorted waste on the waste bins. *(Shunsuke & Satomi, Miyako Ecology Center, 2020)*

iii) *Recycling*

Recycling through exchanging toys amongst the children is being conducted by Miyako ecology center as a practice to encourage their attitude towards sharing. *(Shunsuke & Satomi, Miyako Ecology Center, 2020)*

iv) *Learning about Culture*

Another important aspect is to learn about culture through hands-on experience, for instance, extracting rice from the paddy with the kids in the traditional way on the rooftop of the Miyako ecology center. *(Shunsuke & Satomi, Miyako Ecology Center, 2020)*

2) EDUCATIONAL

i) Creating 'Eco Schools'

In Miyako Ecology Center, the network amongst the primary school support center called 'Eco School'[9] districts (222 at past, currently 165 Eco-School Districts); has been created to help children learn from the local and adjacent ones. *(Shunsuke & Satomi, Miyako Ecology Center, 2020)*

ii) Engaging with Nature for Outdoor learning

According to the outdoor learning advisor of NatureScot *(Personal communication, Penny Martin, NatureScot, 26th January 2021)*, outdoor learning is one of the three strands for 'Learning for Sustainability. They are supporting learning in nature for enhancing nature connectedness that can potentially increase pro-environmental behaviour. *(Personal communication, Penny Martin, NatureScot, 2021)*

iii) Promoting Activities Within Walking Distance

According to NatureScot, the educational activities encourage sustainable approaches to OL by promoting OL activities on the doorstep of schools in their local greenspace, within walking distance. Therefore, environmental organizations are supporting active travel with no carbon footprint. *(Personal communication, Penny Martin, NatureScot, 2021)*

iv) Creating Outdoor learning Map

The 'Greenspace Map for Outdoor learning' by the NatureScot allows teachers, educators, and others to quickly identify green spaces close to their Education establishment that may provide outdoor learning potential (NatureScot). *(Personal communication, Penny Martin, NatureScot, 2021)*

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[9] In Japan, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) has developed the idea of 'Eco School' focusing on three main areas: 1) Facilities: environmentally friendly design and construction, 2) Operations: intelligent and extended use, 3) Education: benefits for learning. (OECD, 2007)

The 'Eco Schools' have environmentally sustainable infrastructures such as (photovoltaic cells (PVC), solar thermal collectors, renewable energy sources, usage of local materials as wood, rooftop greening, and rainwater collectors. In short, they are schools with environmental considerations. The 'Eco Schools' program focuses on sustainable building design as a strategy for practical EE. (OECD, 2007) Kyoto city has zonal divisions for eco-schools called 'Eco-School District'; the Miyako Ecology Center is supporting this program.

v) Creating Sub-textbooks

The Miyako ecology center creates subtext booklets for distributing to primary schools for teaching students about local nature and culture. *(Shunsuke & Satomi, Miyako Ecology Center, 2020)*

3) SOCIO-ECONOMIC

i) Involving Different Stakeholders

The environmental organization's target groups are the Education sector-related community: teachers, partners, and local authorities. According to NatureScot, there are thirty-two Education sectors and other stakeholders across Scotland related to NatureScot for outdoor learning activities. This curriculum considers the activities with people specifically from the age group of 3-18 years old. *(Personal communication, Penny Martin, NatureScot, 26th January 2021)*

ii) Training Activities

The training activities promote increasing experience amongst the local people through conveying messages about the environmental activities & increasing wisdom. *(Hype interviews, Shunshuke, Miyako Ecology Center, 2020)*

EEP by Schools, Lahti City, Finland

1) ENVIRONMENTAL

Outdoor Activity Area in use for Outdoor Activities in Lahti (Maptionnaire, 2017)

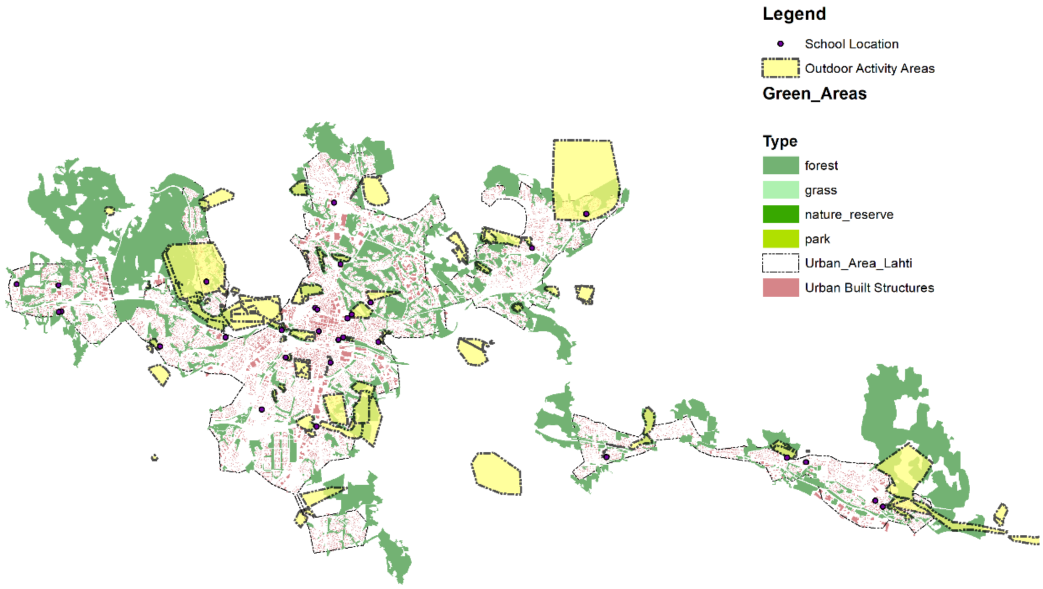


Figure 12 Outdoor activity areas selected by the educators of 35 schools of Lahti (Own Adaptation from Lahti City Questionnaire, 2017; Application: ArcMap 10.6.1)

According to the Maptionnaire data, Lahti City (2017), the average distance for outdoor activities is 524.86m from the schools, and the majority of the areas selected by the educators fall within walking distance (300m) from the schools. The students take part in nature management during their outdoor activities. (Figure 12)

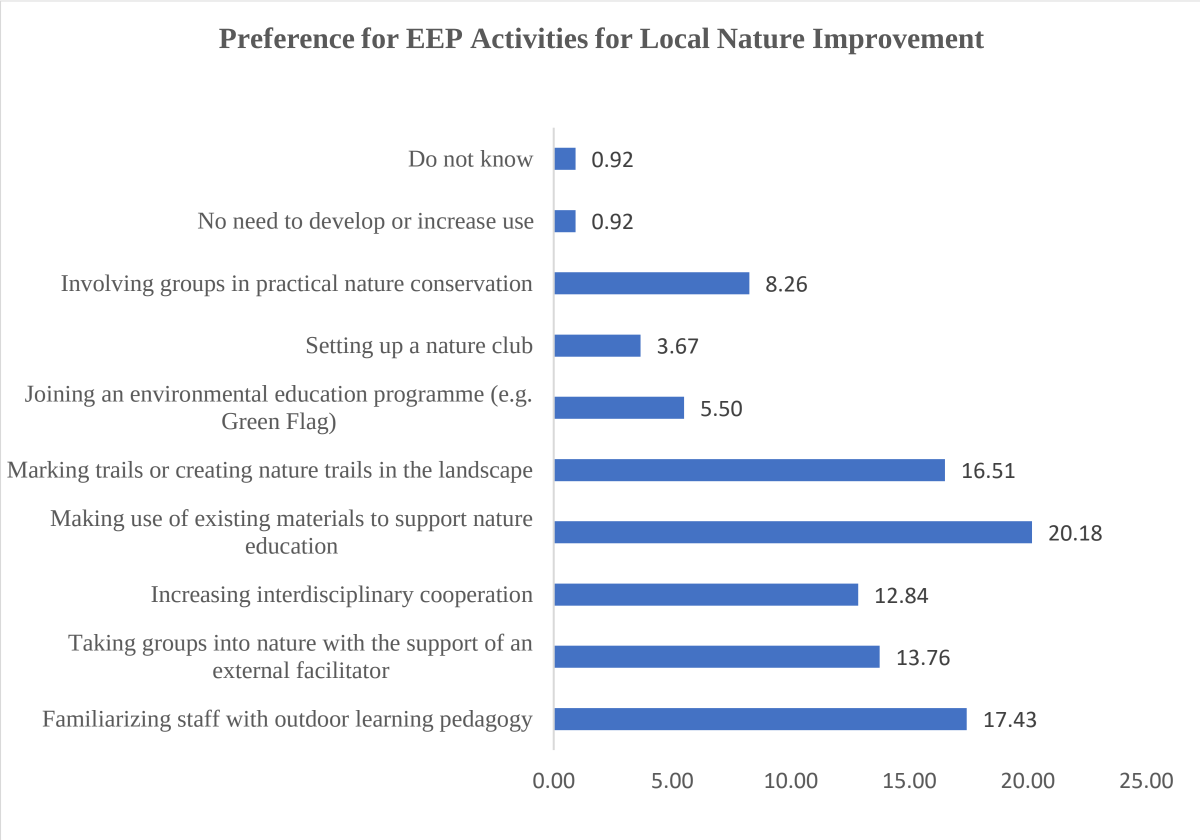


Figure 13 Preference of Educators for EEP Activities for Local Nature Improvement

The preference for local materials usage is the highest (20.18%), followed by familiarizing educators with outdoor learning pedagogy or 'training educators' (17.4%), natural trail development, or in other words- infrastructure development for appreciation of nature or connecting with nature (16.5%), that shows the focus on pro-environmental behaviour development by the educators in Lahti. (Figure 13)

In response to the question related to future collaboration with Lahti City or landowners of the open areas (Figure 14), the educators preferred structures for hiking most (21.82%), followed by setting principles or rules for outdoor activities (14.55%), young people and children participate in planning decisions, mapping the natural areas with OL potential (11.8%) and litter picking as significant activities. The responses show that future possibilities for EEP development are towards Green Infrastructure (GI) development and standardized policymaking with children and community people participation.

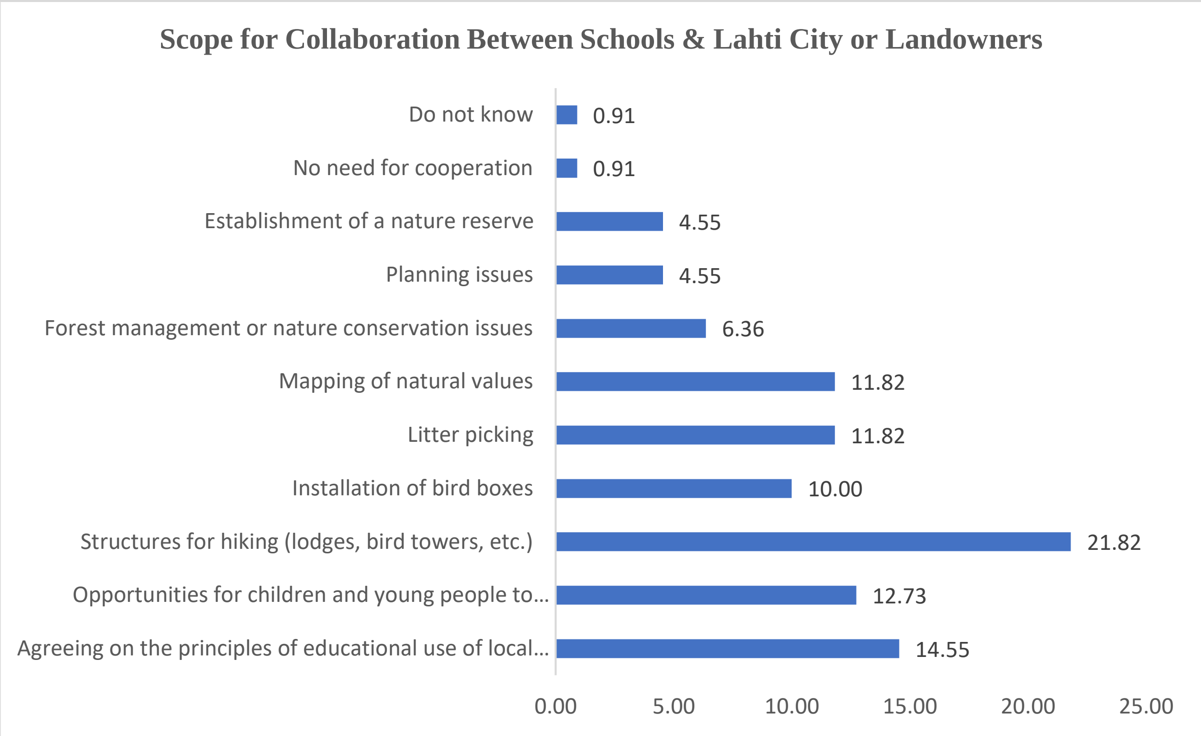


Figure 14 Preferences of educators for future collaboration with Lahti City or landowners for outdoor learning area management for EEP (Lahti City, Mationnaire, 2017)

2) EDUCATIONAL

EEP by schools is focusing on improving the physical and mental well-being of the students. The activities by the schools are as illustrated in the diagram shown in figure (15). Here EEP by the schools in Lahti has been studied since Lahti city has successfully involved in EEP in outdoor areas in collaboration with schools.

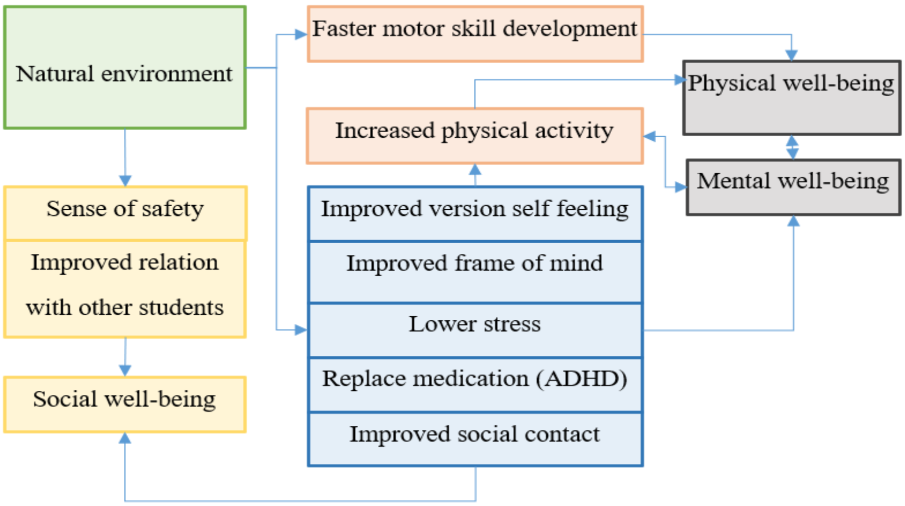


Figure 15 Showing impact of natural environment on student's health and well-being (Own adaptation from Vähäsarja, 2014)

For instance, according to the Maptionnaire survey by the City of Lahti in 2017, with 69 educators from 35 schools in Lahti City as respondents, it was found that the highest involvement of regular school curriculum with outdoor activities was through physical Education (15.76%) and biology (15.76%) followed by visual arts (12.8%), environmental studies (11.33%), multidisciplinary learning unit (10.84%) and Mathematics (7.9%) (Figure 16). Therefore, the scope of incorporating other technical subjects (mathematics, science & arts) from Formal Education into outdoor learning has great potential for future consideration of transforming indoor-based into the outdoor-based learning curriculum.

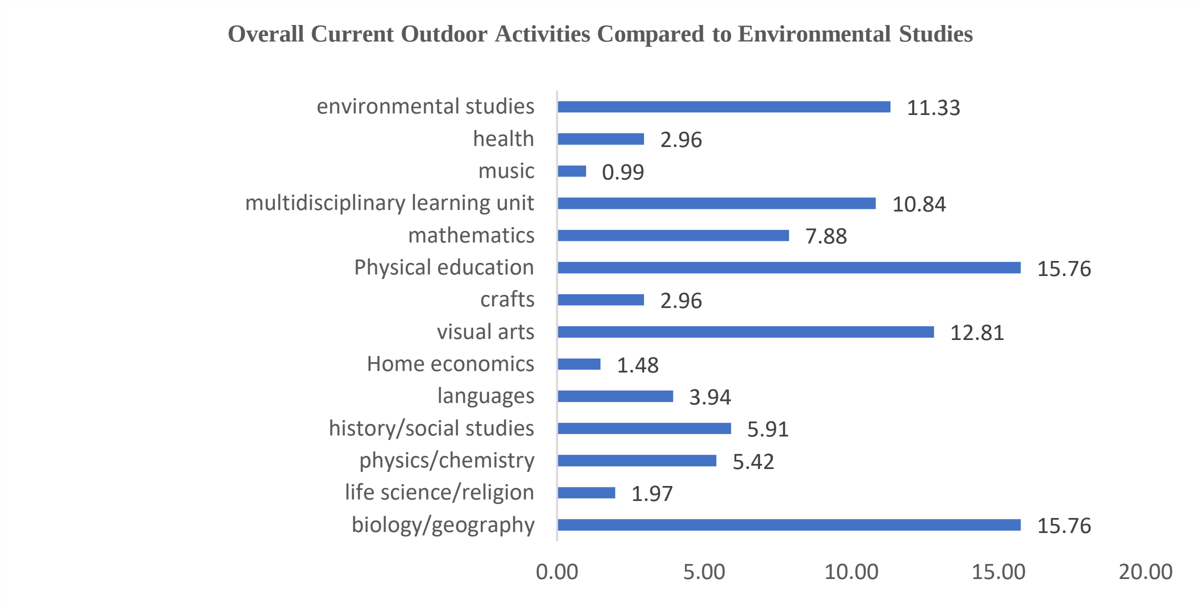


Figure 16 Current subjects or activities conducted outdoor in collaboration with the schools (Lahti City, Mationnaire, 2017)

Summary of Environmental Activities by Different Organizations or Bodies

As illustrated in Table 3, amongst the existing practices by Geoparks and environmental agencies, the driving factor is the collaboration with schools and educational institutions. The level of engagement with nature includes activities with emotional, active, and outward types, depending on the context and possibility to engage actively.

Overall, the amount of direct or active engagement for 'nature management' along with environmental awareness activities amongst the students was found to be 'very high' in the current EEPs by Geoparks compared to outdoor learning practices by NatureScot, Glasgow, Scotland. Again, the environmental practices by Miyako Ecology Center, Kyoto, Japan was found to be very much focused on environmental awareness development along with green infrastructure building promotion, while outdoor activities with students were not found to be a frequent activity. The reason is the unavailability of accessible open areas within proximity of the schools in Kyoto city, as it is densely populated. Instead, the rooftop space is acting as an alternative to outdoor areas for hands-on environmental awareness lessons. (Hype Interviews, 2020). (Table 3)

Activities affecting different parameters		Environmental Education Practices by different env organizations/bodies				
		Geoparks		Nature Centers	Protection	School
		Salpausselkä	Oki Islands	Miyako Ecology Center	NatureScot	Kanerva
Environmental	Managing local green areas	☑	☑	☑	☒	☑
	Monitoring native plant species	☑	☑	☑	☑	☑
	Monitoring water bodies	☑	☑	☒	☑	☑
	Monitoring animal species	☑	☑	☒	☑	☒
	Waste management & recycling	☑	☑	☑	☒	☑
	Green Infrastructure	☑	☒	☑	☑	☒
Educational	Early childhood	☑	☑	☑	☑	☑
	Walking tour	☑	☑	☑	☑	☑
	Inclusion in Formal Education	☑	☑	☑	☒	☑
	Developing Environmental awareness	☑	☑	☑	☑	☑
	Environmental educator engagement	☑	☑	☑	☑	☑
Socio-economic	Connecting with local nature	☑	☑	☒	☑	☑
	Health & well being	☑	☑	☑	☑	☑
	Promoting local materials	☑	☑	☑	☑	☒
	Funding for local business	☑	☑	☒	☑	☒
	Involving individuals in decision making	☑	☑	☑	☑	☒
Engagement		Very High	Very High	High	High	High

Table 3 Comparison of current EEPs considering student engagement level in collaboration with schools

In summary, the adaption of EEP strategy by different bodies specifically for environmental activites can be divided into three major areas: 1) Outdoor Area Based, 2) GI Based, and 3) Combined (Outdoor + GI) Strategy. (Figure 17)

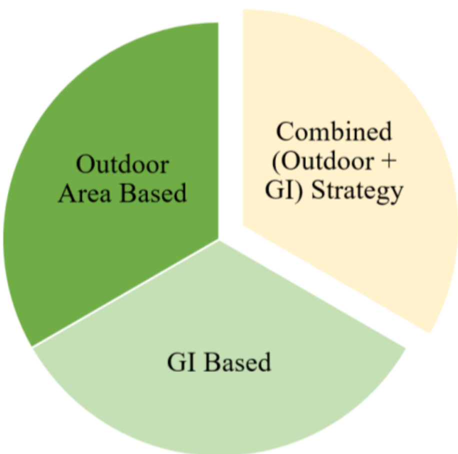


Figure 17 Key Strategies for EEPs by Different Bodies (Own adaptation)

4.2. Section 2

4.2.1. General comparison of exposure to nature amongst schools in Lahti and Dhaka

Lahti City	Dhaka City
Inner city area or urban built-up area: 155 Sq km Population: 103000 Age 0 to 14: 14.3% Number of schools within the Urban Area: 31 *(source: European Green Capital Award Application, Lahti City, 2021, National Land Survey of Finland (NLS), 2021)*	Inner city area or urban built-up area: 300.96 Sq km Population: 20,989,000 Number of schools within the Urban Area: 324 *(Source: Open source data (Geofabrik.de), Dhaka South City Corporation (DSCC), Bangladesh Bureau of Statistics)*

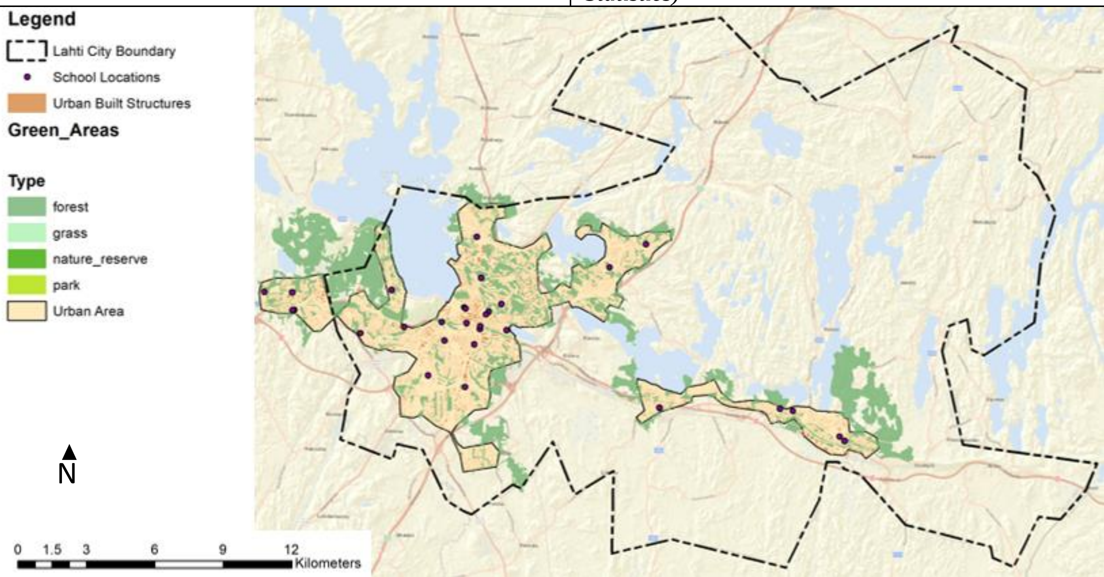


Figure 18 Lahti City area and urban built-up area map considering existing parks and green areas (Application: ArcMap 10.6.1)

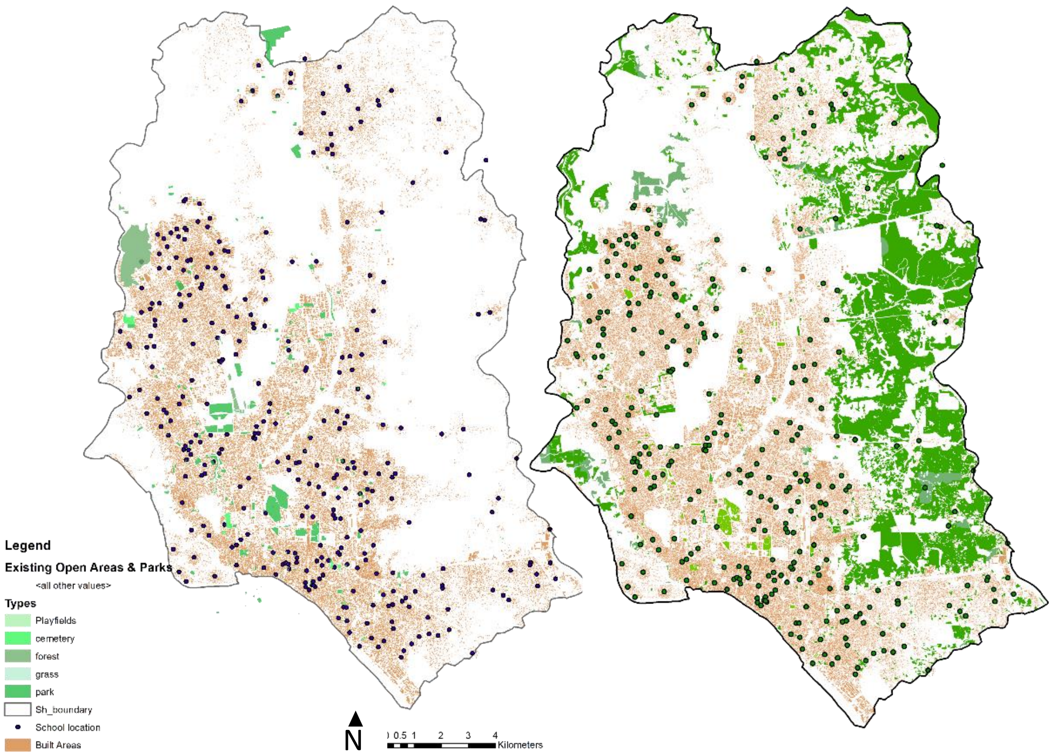


Figure 19 i) Dhaka city area and urban densely built-up area with inner-city existing green areas, parks, playfields and open spaces (Left), ii) existing marshy green areas alongside the city periphery (right)

In figure 19 (i) and (ii), it has been illustrated that the accessible parks, green areas, and playfields inside the dense urban area of Dhaka City are much lesser in ratio compared to the built-up area. The majority of the school's location falls within the densely built-up area of the city. For Lahti city, the overall green area within the inner-city or dense urban area is 9.79 sq km, which means the existing accessible urban park area is 7% of the total densely built-up area. On the Other hand, in Dhaka city, the overall green area within an inner-city or dense urban built-up area is 3.56 sq. km, which means the existing accessible green areas are only 1% of the total densely built-up area.

The general comparison of an overall distribution of selected natural features considering the locations of the schools has been conducted for having better insights into the selected cities. : 1) Proximity to existing parks, 2) Overall green within 250m buffer, 3) Dense vegetation or tree-canopy cover within parks, 4) Proximity to Blue Infrastructures, and 5) Blue infrastructure area within 250m buffer. Remote sensing data derived from Sentinel 2A with a spatial resolution of 10m x 10m have been considered for existing natural areas analysis in both cities. For analysis, only densely built-up areas covering the location of the schools have been considered in both cities.

4.2.2. Proximity to Green analysis ($\boldsymbol{I_a}$)

Lahti City		Dhaka City	
Minimum distance to greeneries:	0m	Minimum distance to greeneries:	0m
Maximum distance to greeneries:	217.900986m	Maximum distance to greeneries:	4696.748047m
Average distance to greeneries:	91.309852m	Average distance to greeneries:	683.812652m

Table 4 Distances of nearby green areas considering school locations (Application: ArcMap 10.6.1)

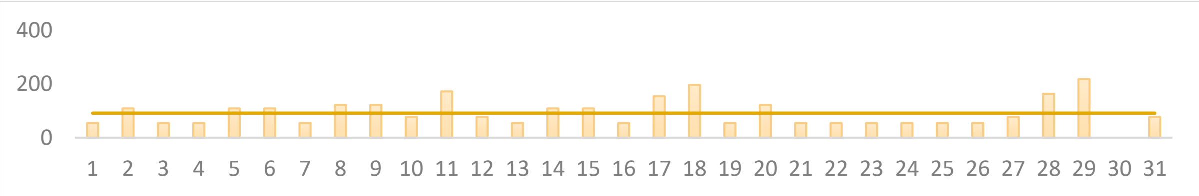


Figure 20 Distances of nearby green areas considering 31 school locations in Lahti (Application: Excel)

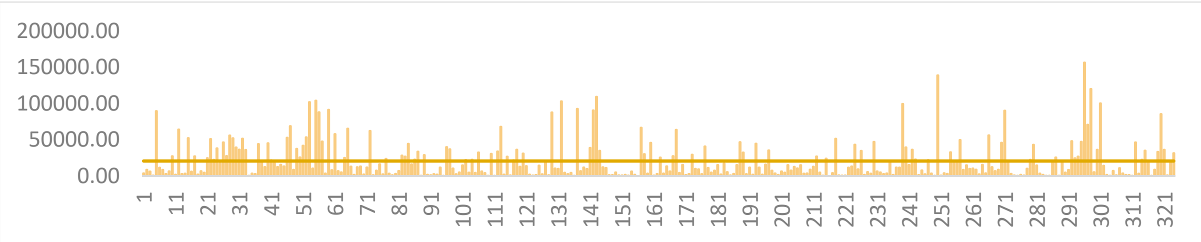


Figure 21 Distances of nearby green areas considering 324 school locations in Dhaka (Application: Excel)

From the analysis of Euclidean the distance to existing parks, playfields, and open areas of both cities, the results show that all the 31 schools of Lahti have green areas within 250m distance. The mean distance for the nearby green areas considering the locations of the schools is 91.3m in Lahti. On the other hand, only 93 schools from the 324 schools in Dhaka have the presence of local green areas within 250m buffers from school locations. The average distance for nearby green areas from the schools is 683.8m, which is almost 7.5 times more than Lahti's schools' average distance to green areas.

4.2.3. Dense Green or Tree-canopy Cover in Parks Within 250m Buffer (I_b)

Lahti City	Dhaka City
Minimum tree canopy-cover areas: 278 sqm Maximum tree canopy-cover area: 91900 sq m Average tree canopy-cover area: 29066.67 sqm	Minimum tree canopy-cover areas: 0 sqm Maximum tree canopy-cover area: 44300 sqm Average tree canopy-cover area: 1550.5 sqm

Table 5 Dense vegetation or tree-canopy cover in parks within 250m buffer

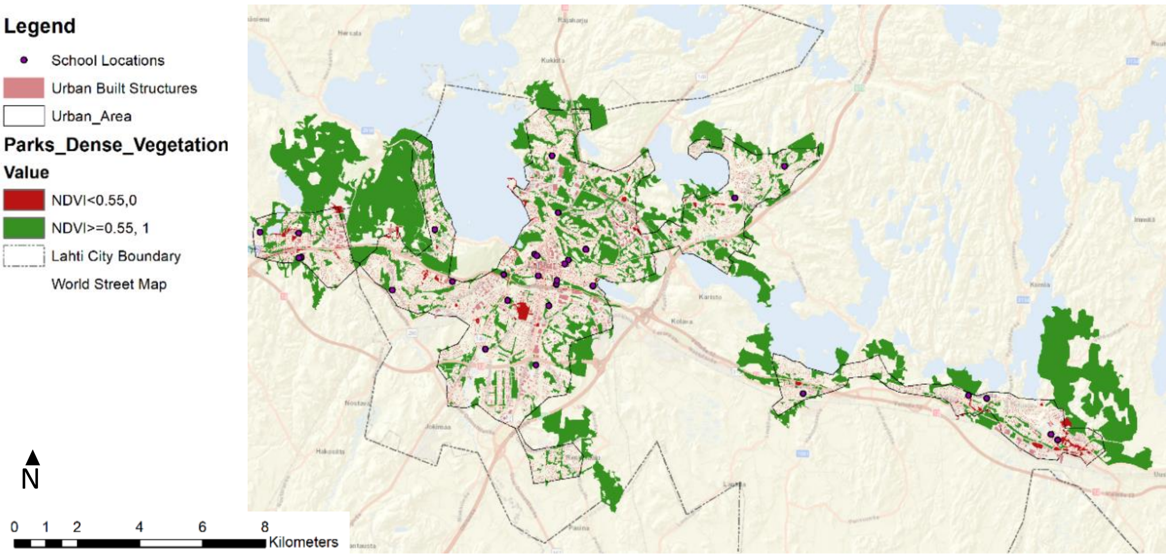


Figure 22 Percentage of Active green (NDVI>0.55) in proportion to overall green in existing parks within 250m buffer is 92.8%. The parks or green areas with trees detected with lesser active green are located mostly near the city center area.

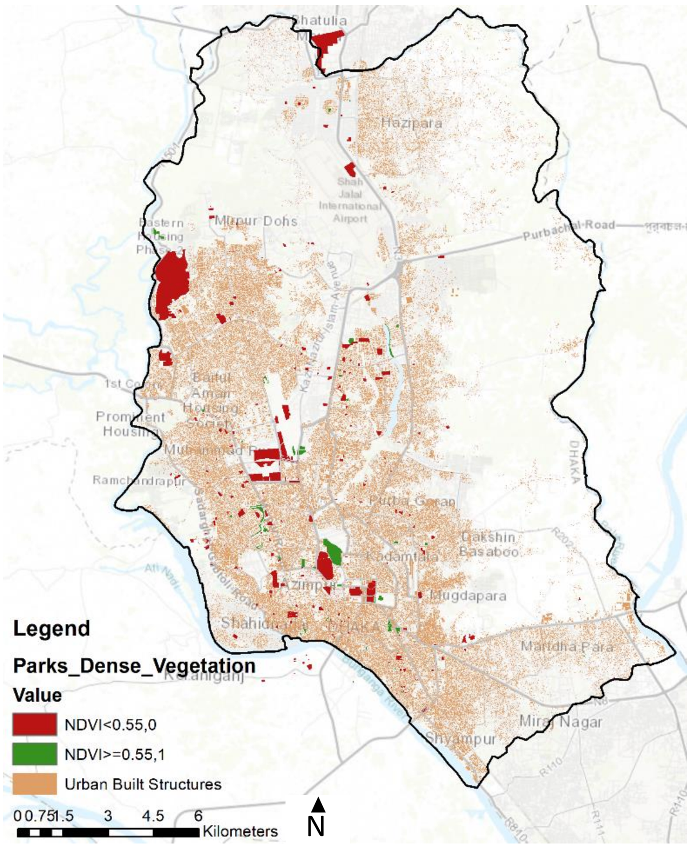


Figure 23 Percentage of active green (NDVI>0.55) in proportion to overall green in existing parks within 250m buffer is 12.36%. Majority of the trees in existing parks didn't show similar (NDVI>0.55) value for greenness as was detected in the trees located in densely vegetated areas.

4.2.4. Overall Green Area Within 250m Buffer (I_c)

Lahti	Dhaka
Minimum area with green: 400.00 sqm Maximum area with green: 143500.00 sq m Total green area within 250m buffer of 31 schools: 2528700.00 sq m Average green area within 250m buffer of schools: 81570.97 sq m	Minimum area with green : 0 sqm Maximum area with green: 156400.00 sq m Total green area within 250m buffer of 324 schools: 6725400.00 sq m Average green area within 250m buffer of schools: 20693.54 sq m

Table 6 Overall green (NDVI>=0.45397) within 250m buffer of schools

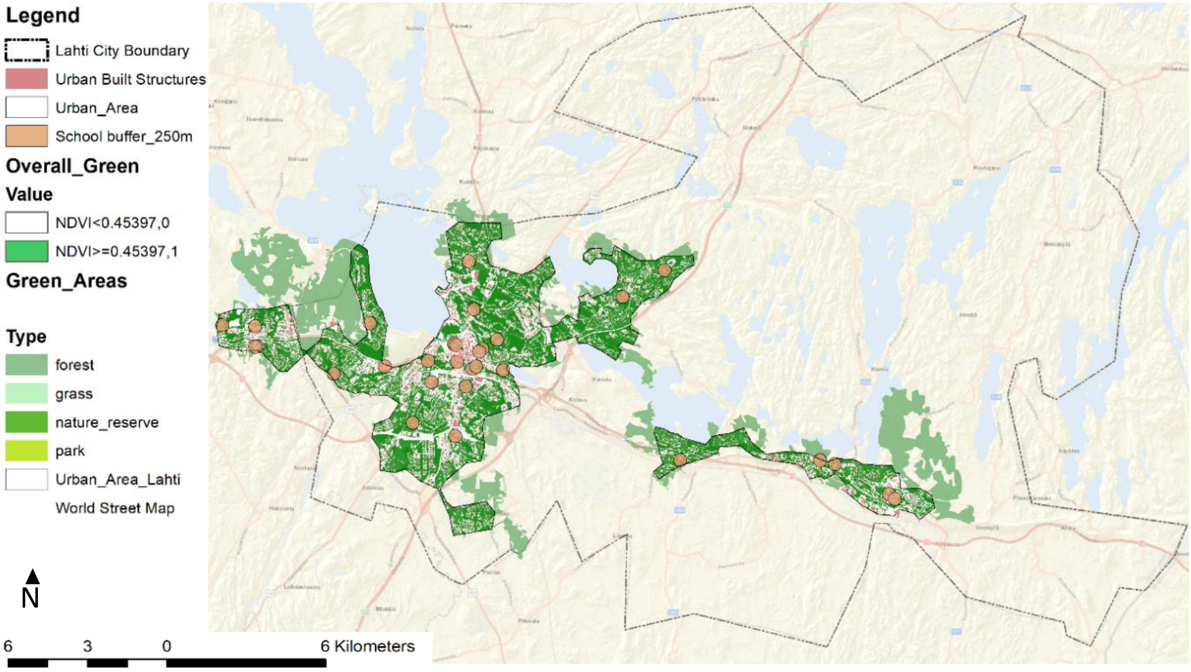


Figure 24 Overall Green (NDVI>=0.45397) Within 250m Buffer of schools in Lahti (Application: Arcmap 10.6.1)

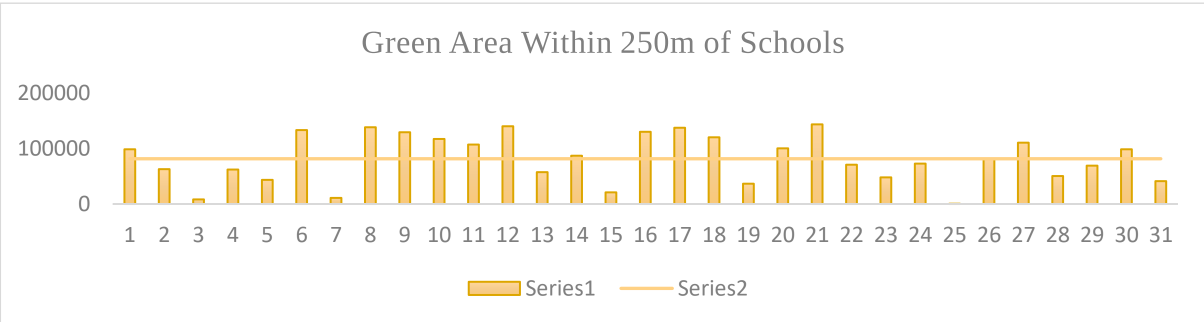


Figure 25 Series1_Overall Green (NDVI>=0.45397) area distribution within 250m buffers; Series2_Average green area within 250m buffer of selected schools in Lahti (Application: Excel)

Total green area within 250m buffer, $A_{Green} = \sum_{i=1}^{i=31} A_{NDVI\geq0.45_i}$ (7)

Total considered area of buffer, $A_{total} = \pi r^2 \times i$ (8)

Here, i = Number of schools

Overall green area percentage: $R_{GreenArea} = \frac{A_{Green}}{A_{total}} \times 100$ (9)

$$= \frac{2528700}{31 \times 196349.541} \times 100$$

$$= \mathbf{41.5\%}$$

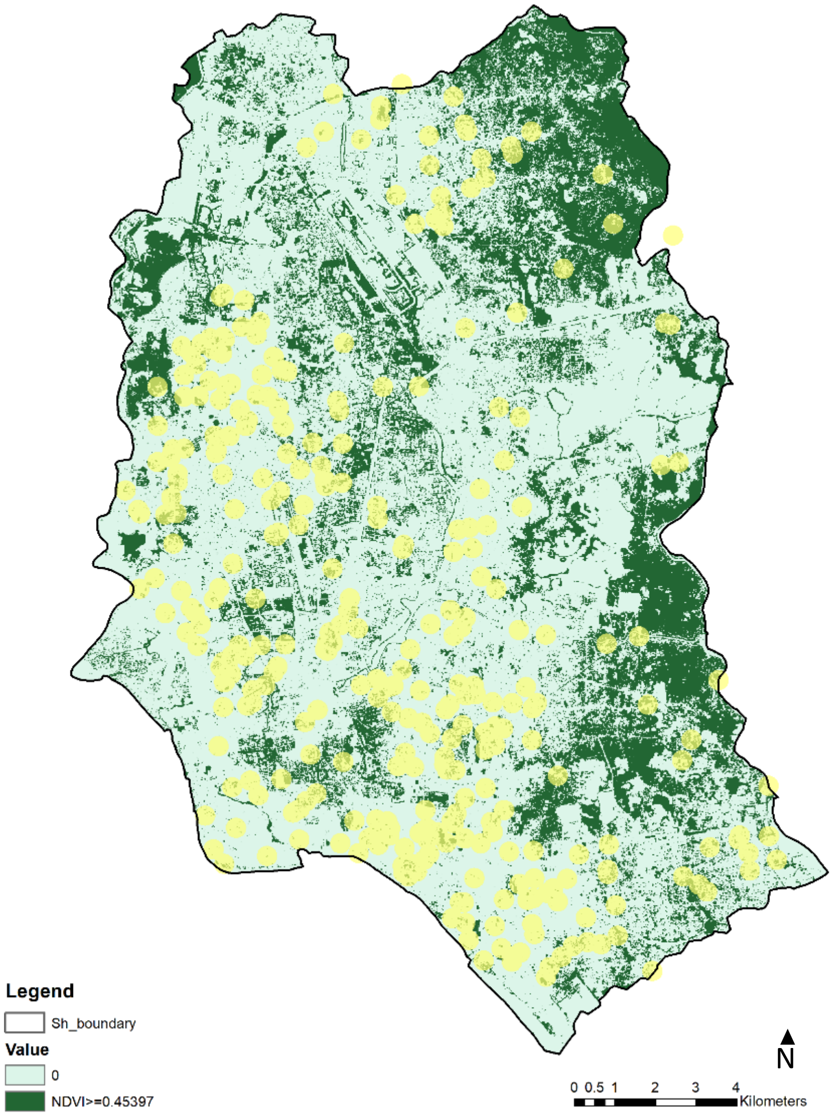


Figure 26 Overall Green (NDVI>=0.45397) within 250m buffer of schools in Dhaka (Application: Arcmap 10.6.1)

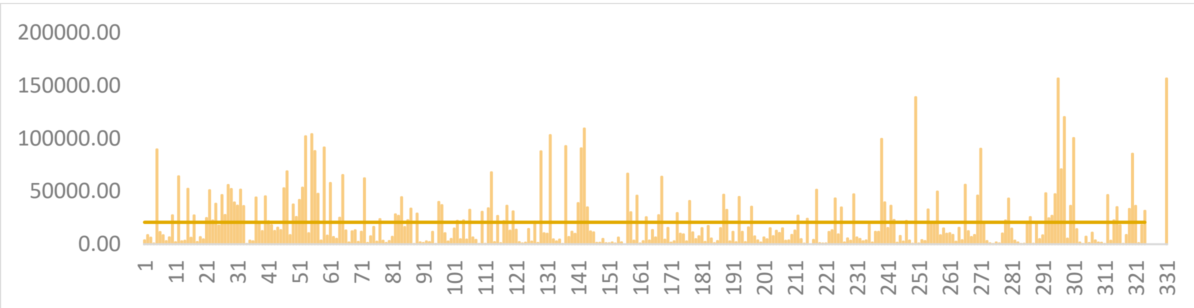


Figure 27 Series1_Overall Green (NDVI>=0.45397) area distribution within 250m buffers; Series2_Average green area within 250m buffer of selected schools in Dhaka (Application: Excel)

Overall green area percentage calculation following equation 7,8, and 9:

$$R_{GreenArea} = \frac{A_{Green}}{A_{total}} \times 100$$

$$= \frac{6725400}{324 \times 196349.541} \times 100$$

$$= \mathbf{10.57\%}$$

4.2.5. Proximity to Waterbodies ($\boldsymbol{I_d}$) and Waterbody Area Within 250m Buffer ($\boldsymbol{I_e}$)

Lahti	Dhaka
Minimum distance to waterbodies: 138.3488m Maximum distance to waterbodies: 1779.1m Average distance to waterbodies: 818.9948m	Minimum distance to waterbodies: 27.28m Maximum distance to waterbodies: 883.81m Average distance to waterbodies: 303.5299013m

Table 7 Exposure to waterbody analysis considering Euclidean Distance and MNDWI values

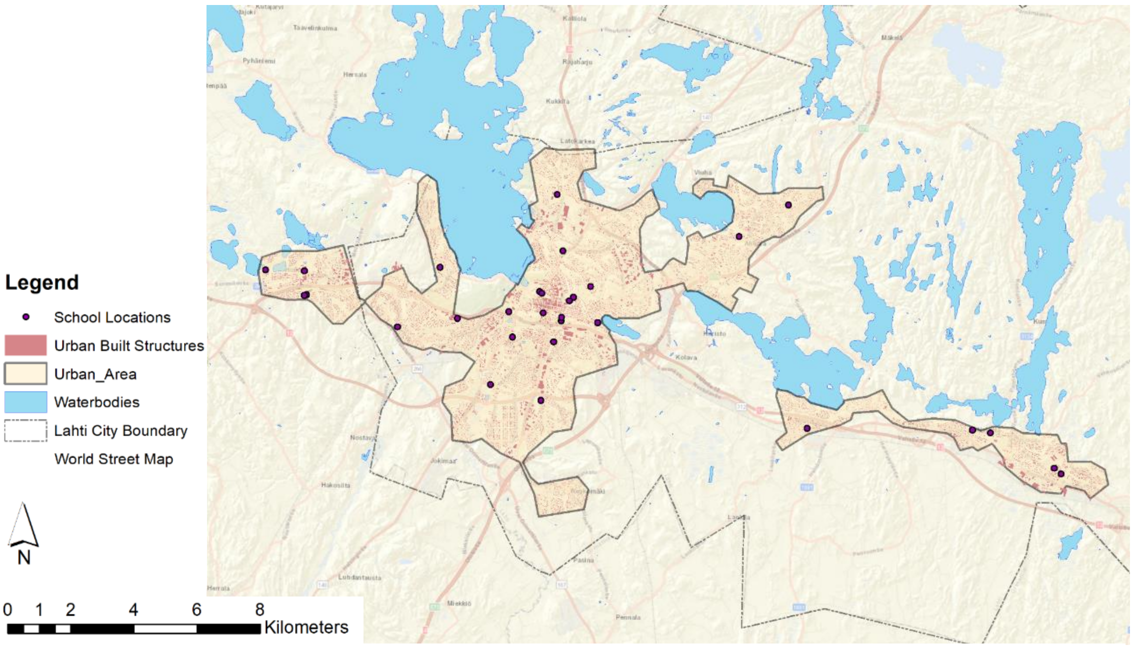


Figure 28 Overall exposure to blue infrastructure in Lahti from selected school locations (Application: ArcMap 10.6.1)

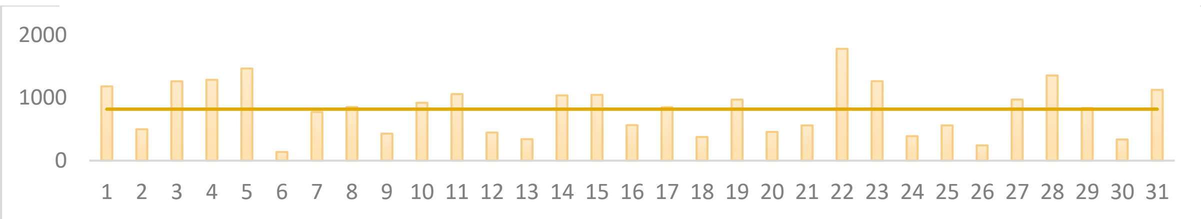


Figure 29 Proximity to waterbodies from 31 school locations in Lahti (Application: Excel)

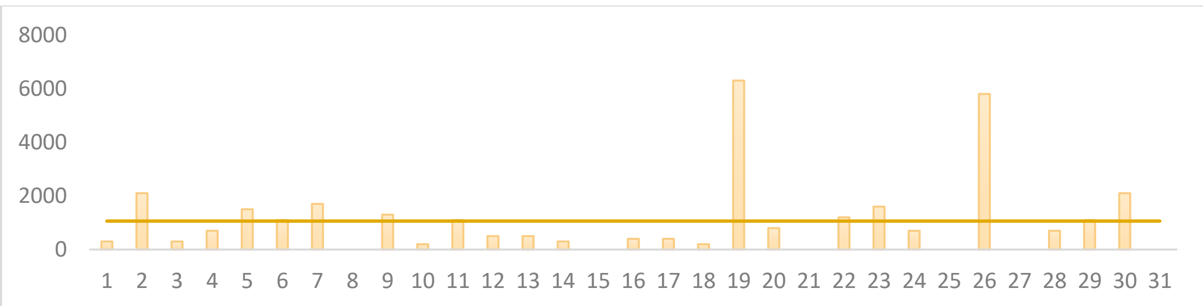


Figure 30 Waterbody area within 250m buffer of 31 schools in Lahti (Application: Excel)

Figure 29 and figure 30 illustrate the exposure to blue infrastructures considering the selected school locations in Lahti. The minimum waterbody area within 250m buffer is 0 sqm, which means no waterbody present within 250m buffer, while the maximum waterbody area within 250m buffer is 6300 sqm. The average waterbody area within the 250m buffer of schools is 1096.6667 sqm.

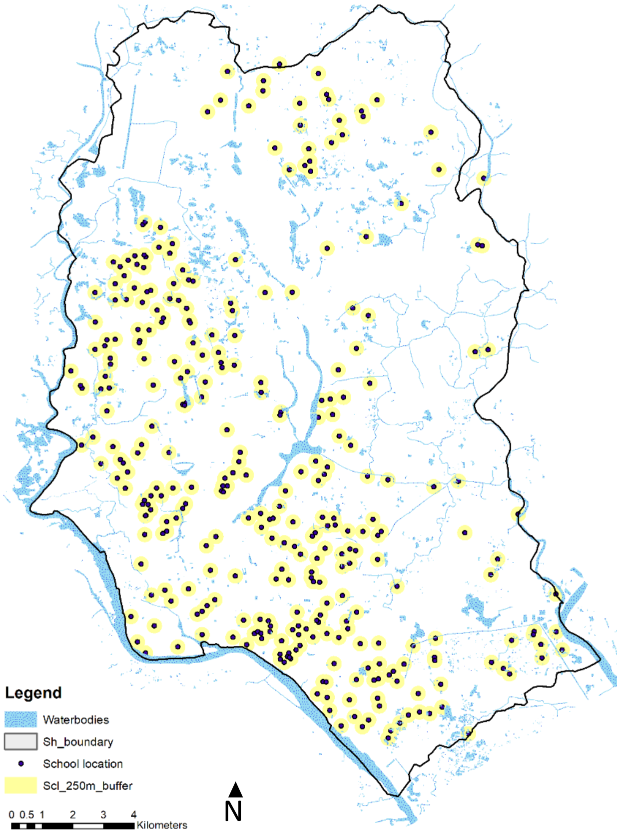


Figure 31 Overall exposure to blue infrastructure in Dhaka from selected school locations (Application: ArcMap 10.6.1)

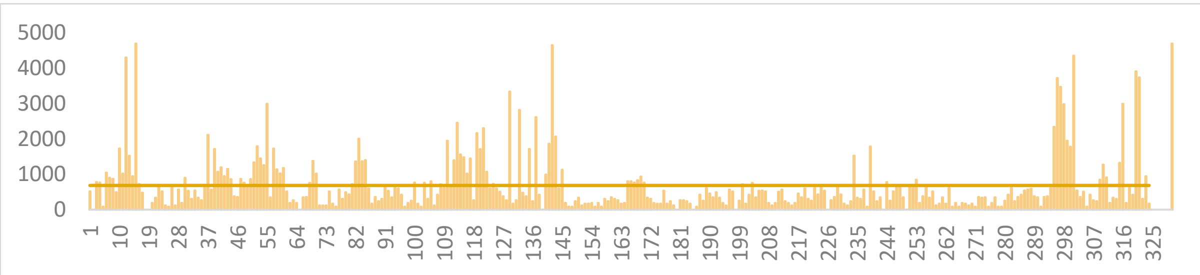


Figure 32 Proximity to waterbodies from 324 school locations in Dhaka (Application: Excel)

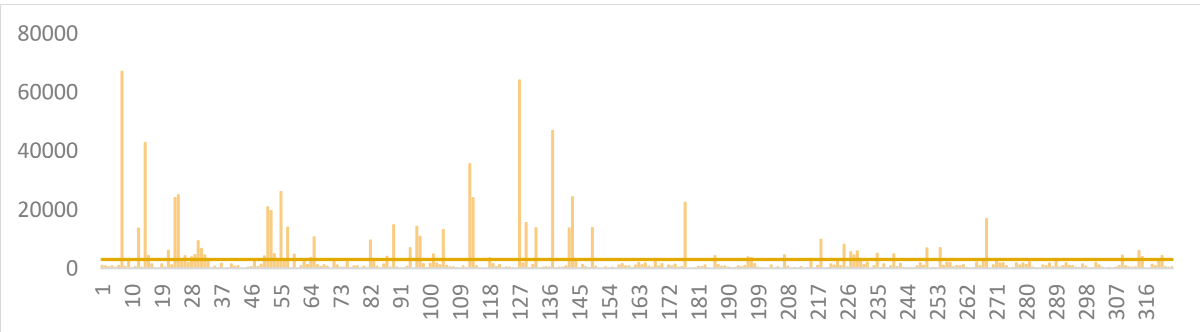


Figure 33 Waterbody area within 250m buffer of 324 schools in Dhaka (Application: Excel)

Figure 32 and figure 33 illustrate the exposure to blue infrastructures considering the selected school locations in Dhaka. The minimum waterbody area within 250m buffer is 0 sqm, which is similar to the case of the schools in Lahti, while the maximum waterbody area within 250m buffer is 67000 sqm, which is close to the Buriganga River in Dhaka. The average waterbody area within the 250m buffer of schools is 3043.518519 sqm that is almost three times more than Lahti. This is due to the city has lots of canals and is surrounded by three major rivers.

4.2.6. Overall Natural Environment Distribution

The overall exposure to nature from school locations and 250m buffer neighborhood scale has been calculated following simple average as shown in equation (3) and for normalization of indicators equation (2) has been used.

Lahti	Dhaka
Minimum value of Nature Exposure:0.23 Maximum value of Nature Exposure: 0.71 Average value of Nature Exposure: 0.45 Standard Deviation from Mean: 0.1342	Minimum value of Nature Exposure: 0.19 Maximum value of Nature Exposure: 0.59 Average value of Nature Exposure: 0.34 Standard Deviation from Mean: 0.066

Table 8 Exposure to Nature considering simple average of indicators

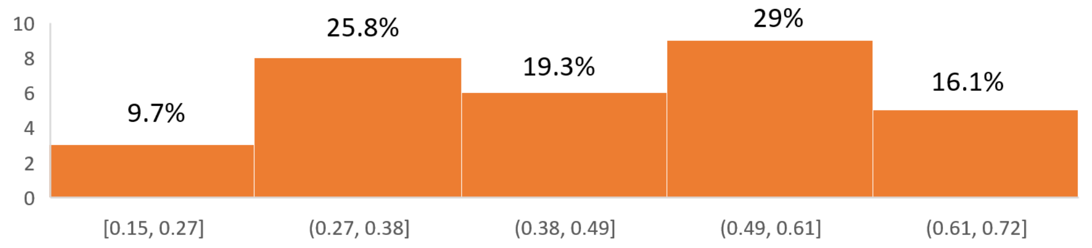


Figure 34 Normalized Average Exposure to Nature in Lahti amongst 31 schools (Own Adaptation, Application: Excel)

Here, the distribution pattern of 'Overall Nature' in Lahti, considering the location and 250m buffer of schools, shows high variability in distribution with an average value of 0.45 and a Standard Deviation (STD) of 0.1342 amongst the schools. 45.1% of the schools fall within the 'High' to 'Very high' in total, 19.3% within 'Moderate', 35.5% within 'Less' and 'Very less' category. Although the data have high STD, the distribution shows uniformity in general.

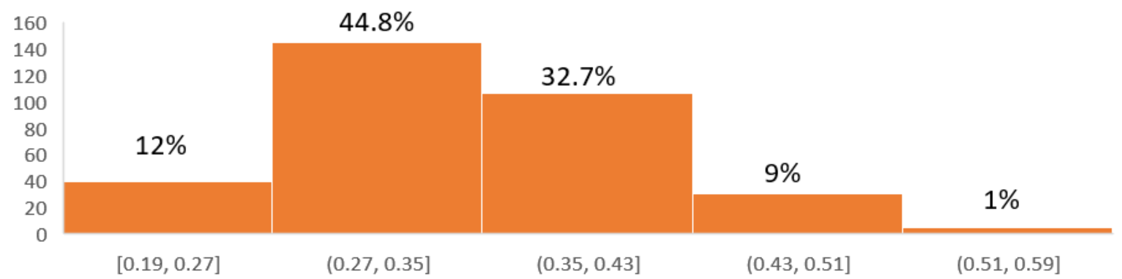


Figure 35 Normalized Average Exposure to Nature in Dhaka amongst 324 Schools (Own Adaptation, Application: Excel)

In Dhaka, the distribution shows a left-skewed pattern with the majority of the schools (56.8%) falling within the 'Less' and 'Very less' category with 32.7% schools in moderate and only 10% schools in 'High' to 'Very high' category of exposure to overall nature. The 324 schools show an STD of 0.066 from a Mean value of 0.34, which means less variability in 'Exposure to Nature' within the urban area.

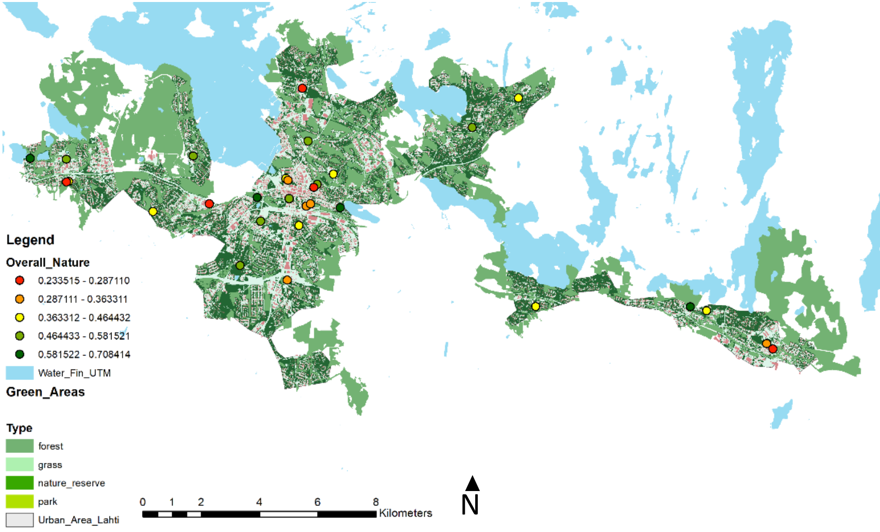


Figure 36 Overall Exposure to Nature within Urban Area, Lahti (Application: ArcMap 10.6.1)

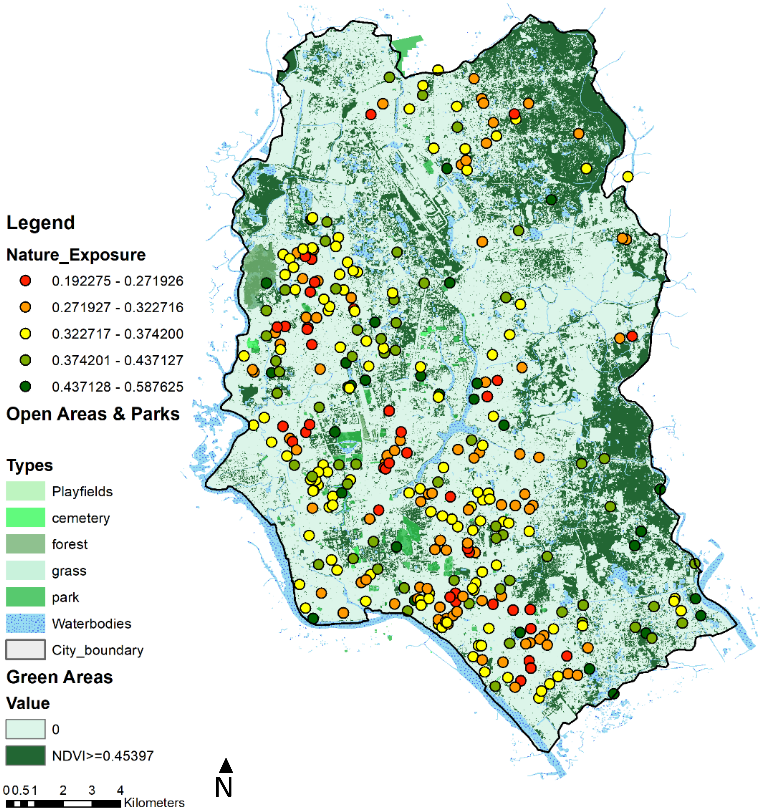


Figure 37 Overall Exposure to Nature within Urban Area, Dhaka (Application: ArcMap 10.6.1)

In summary, schools falling within the 80th percentile of 'very less' exposure to nature are located near the densely built-up areas in both cities. However, in Lahti, all the schools have 'medium' to 'very high' exposure to nature with a minimum normalized value of 0.23 and a minimum green area of 400 sqm within 250m buffer. Inversely, the majority of the schools in Dhaka have 'very less' or no accessible natural areas nearby. The minimum normalized value of overall exposure to nature is 0.19, and the minimum green area within a 250m buffer is 0 sqm.

4.3. Section 3

4.3.1. Case Study Schools in Lahti and Dhaka

<u>Case Study Schools</u>

Selected Schools in **Lahti:**

A. Tiirismaan Peruskoulu
B. Kukkasen Koulu

Selected schools in **Dhaka:**

C. Monipur High School & College
D. Ganobhaban Govt High School

A	B	C	D

School Id: A

Location: City Center, Lahti, Finland

Lower exposure to nature and higher exposure to urban stressors, lower potential for outdoor EEP

School Id: B

Location: Suburb, around 15km distance from city center, Lahti, Finland

Higher exposure to nature and lower exposure to urban stressors, higher potential for outdoor EEP

The total student number of selected schools is around 700 (official school website). The survey was conducted using a 'Maptionnaire' based questionnaire (Annex 03), in total 123 respondents took part in the survey resulting in a confidence level of 85% with a z-score of 1.44 and a 6% margin of error. Permissions from the Lahti City and headteachers of the selected schools were collected to proceed with the survey.

School Id: C

Location: Mirpur, Dhaka

Lower exposure to nature and higher exposure to urban stressors, lower potential for outdoor EEP

School Id: D

Location: Mohammadpur, Dhaka (close to National Parliament Building & Zia Uddin Park). Higher exposure to nature and lower exposure to urban stressors, higher potential for outdoor EEP

The total student number of selected schools is approx. 5232 (BANBEIS statistics), student number from selected age group is around 700. The sample size has been considered only for the age group of 14-16 years old in this case. The survey was conducted using 'Google Form' using same questions as mentioned in (Annex 03); in total, 121 responses were received with a confidence level of 85%, a z-score of 1.44, and a 6% margin of error. Permission from the parents of the students and the teachers was collected to proceed with the survey.

4.3.2. Comparison of Student's responses in Lahti & Dhaka

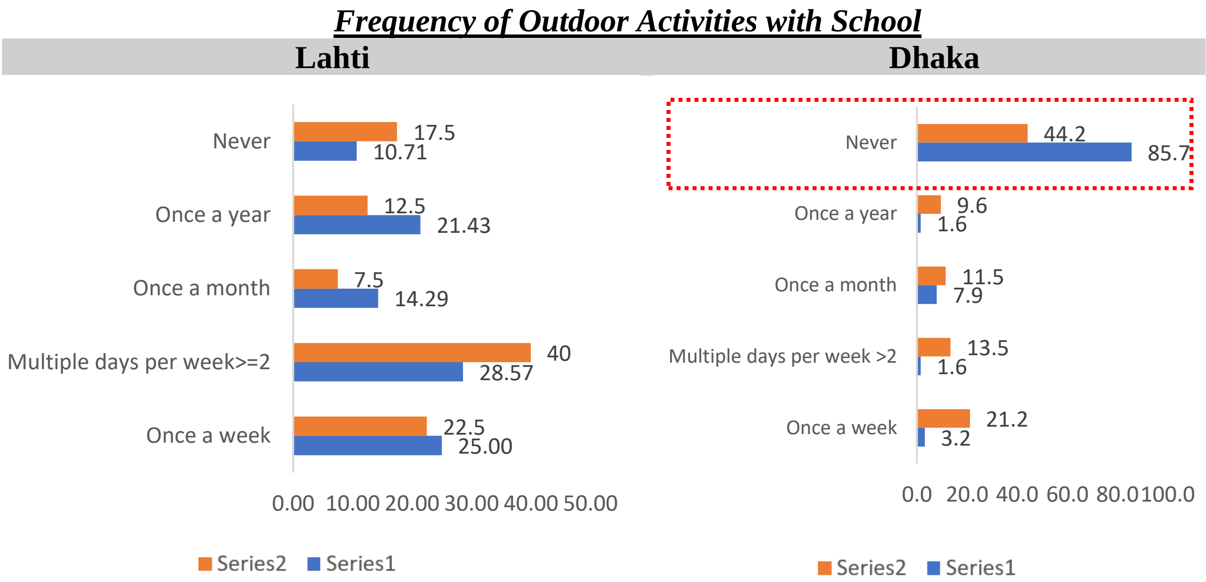


Figure 38 Frequency of outdoor activities by schools in Lahti and Dhaka (Series1- School A & School C, Series2- School B & School D)

Lahti
School A, series 1, N1= 28
School B, series 2, N2= 40
89.8% of students have responded on average more or less frequent outdoor activities with the school. School B showed a lesser percentage (87.7%) of frequency of visits compared to School A (91.9%). Outdoor Acitivity Index (OAI) has been calculated following 'Satisfaction Index' by Yeh and Tan 1975

$$\text{Oudoor Activity Index; } I_{OA} = (f_p - f_n)/\text{n} \quad (10)$$

Here, $f_p = positive\ response$
$f_n = negative\ reponse$
n $= N_i$, number of responses
School A,

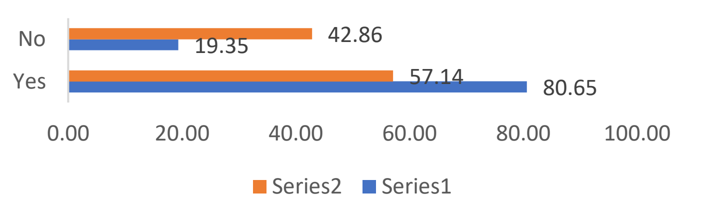
$$I_{OA} = (25 - 3)/28$$
$$= \mathbf{0.79}$$

School B,

$$I_{OA} = (33 - 7)/40$$
$$= \mathbf{0.65}$$

The frequency of visits has been normalized for comparison. The less green proximity school A scored higher than more green proximity school B in Lahti.

During COVID19
Less Green Proximity School, A
$$I_{OA} = (25 - 6)/31$$
= **0.61**
More Green Proximity School, B
$$I_{OA} = (28 - 21)/49$$
= **0.14**



Dhaka
School C, N1= 63
School D, N2= 52
Only 14.3% students have responded on average more/less frequent outdoor activities with school C while high green proximity school, D showed a higher percentage (35.8%). Now, following the equation (10), OAI score both schools are,
School C,
$$I_{OA} = (9 - 54)/63$$
= **-0.83**
School D,
$$I_{OA} = (29 - 25)/52$$
= **0.08**

During COVID19[10]
School C, $I_{OA} = 0$
School D, $I_{OA} = \left(\frac{0-1}{1}\right) = -1$

Types of Outdoor Activities with School

Lahti	Dhaka

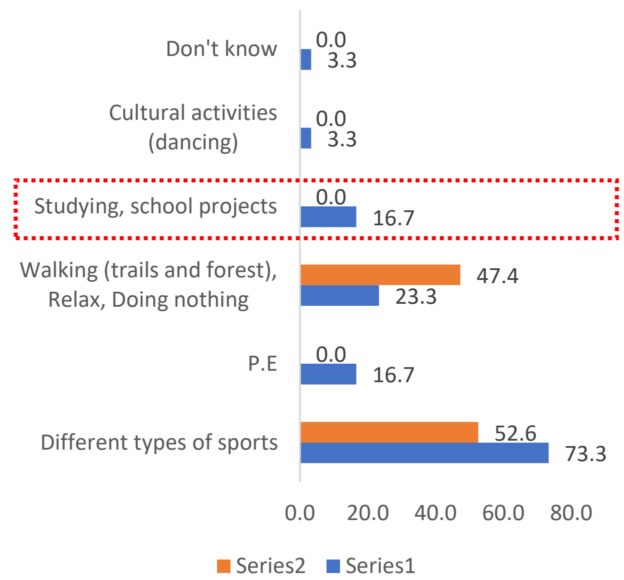


Figure 39 Outdoor Activities by Schools, Lahti, Series1- School A, Series2- School B

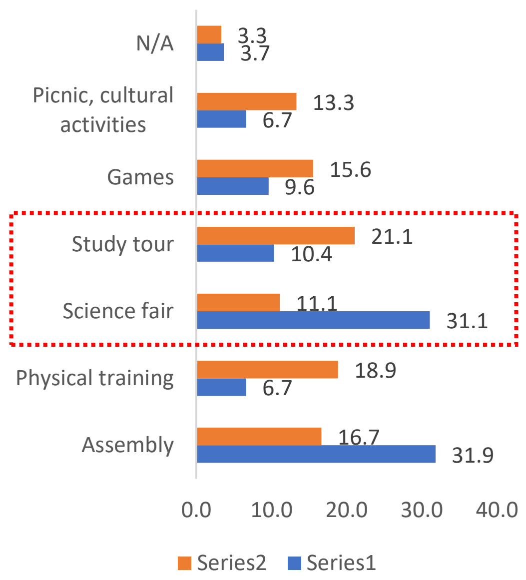


Figure 40 Outdoor Activities by Schools, Dhaka, Series1- School C, Series2- School D

[10] According to the educators of school close to green area in Dhaka, there have been occasional gatherings (1/2 rimes a year) since the closure of educational instituions started.

Lahti
School A, N1= 37
School B, N2= 57

School A students reported highest percentage of outdoor activities related to sports and physical exercise **(73.3%).** School B showed a higher percentage **(47.4%)** of nature appreciation activities than School A **(23.3%).**

Dhaka
School C, N1= 135
School D, N2= 90

School C showed highest percentage of OA related to assembly and science fair **(31.9%, 31.1%).** There has been no mention of nature appreciation activities in Dhaka. School D showed higher percentage of physical activities **(18.9%)** than school C **(6.7%)**.

Educational Activities in Outdoor
The responses have been calculated based on Outdoor Education Index (OEI) similar to equation 10,

$$\text{Oudoor Education Index; } I_{OE} = (f_{EA} - f_{OA})/\text{n} \tag{11}$$

Here, f_{EA} = No. of Outdoor Educational activity responses
f_{OA}= No. of non-Educational outdoor activity responses
n $= N_i$, number of responses

Lahti	Dhaka
School A = -0.75, (N1=40)	**School C**= 0.01, (N1= 130)
School B = -1, (N2=19)	**School D** = -0.33, (N2= 87)
During COVID19	**During COVID19**[11]
School A = -0.54, (N1=35)	**School C**= 0, (N1= 0)
School B = 0.18, (N2=19)	**School D**= -1, (N2= 1)

Even though calculated OEI score in Dhaka is higher, the frequency of the outdoor educational activities is very infrequent. Therefore, the impact is insignificant. On the other hand, even though the score of Lahti is lesser on magnitude, considering it is very frequent, the impact is very high. However, in both cities, more nature showed more physical activities outdoors.

[11] * Schools have been closed Since March 2020, studies are being conducted through online and worksheet distribution. However, according to the educators of school close to green area, the school fields have been used for occasional cultural gatherings on National day (Personal communication, Educators, Dhaka 2021)

Transportation Usage Behaviour

Lahti	Dhaka

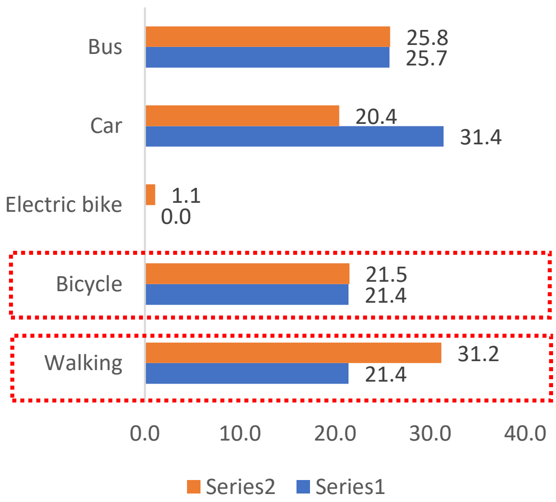


Figure 41 Transportation usage tendency of students, Lahti, Series1- School A, Series2- School B

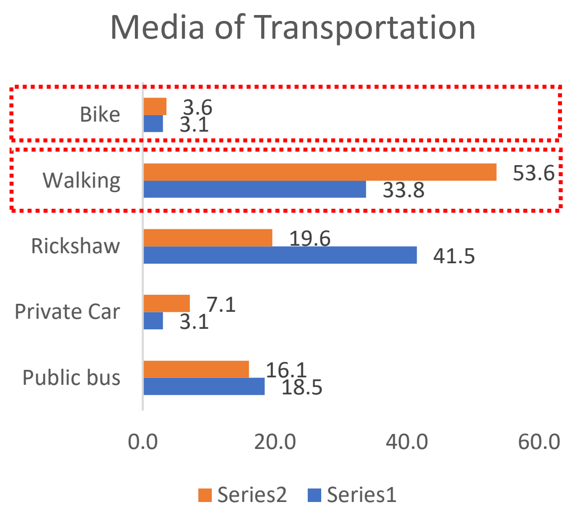


Figure 42 Transportation usage tendency of students, Dhaka Series1- School C, Series2- School D

In both cities, students from schools located near nature have a higher percentage of walking. However, in Dhaka, the rickshaw is the second most used vehicle followed by public bus, while in Lahti, public buses and bicycles have the second and third highest percentage. However, the comparison between bike usage between the two cities shows that Dhaka is significantly lagging in bike usage. Despite that, the close green proximity school has more bike users compared to the less green proximity school in Dhaka. But in Lahti, both schools showed the same percentage of users.

Identified Problems Related to Outdoor Activity (OA)

Lahti	Dhaka

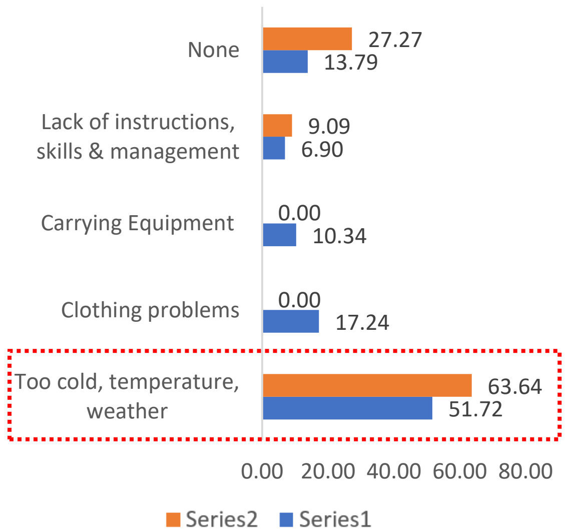


Figure 43 Problems related to OA, Lahti, Series1- School A, Series2- School B

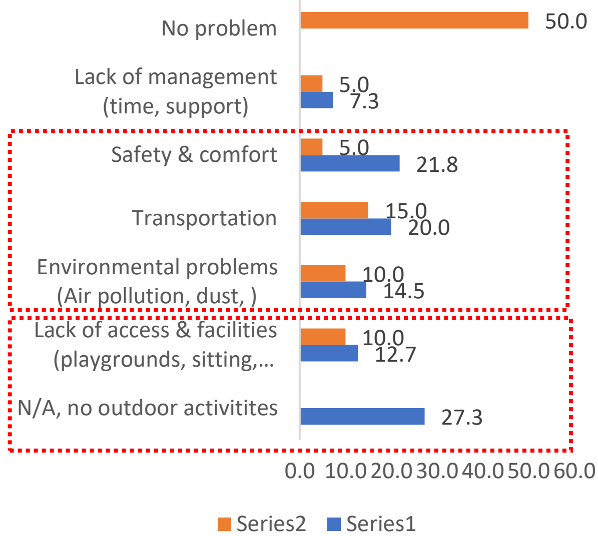


Figure 44 Problems related to OA, Dhaka, Series1- School C, Series2- School D

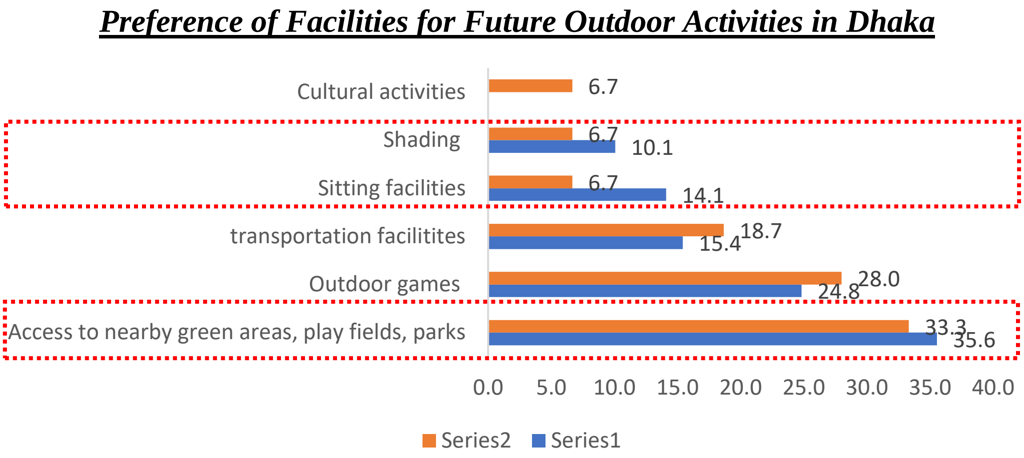


Figure 45 Preference of Facilities by students for consideration of future outdoor based EEP establishment, Series1- school C, Series2- school D

The problems related to conducting outdoor activities in both cities can be divided into the following major categories:

1. The opportunity of OA (accessibility, existing facilities, and management)
2. Comfort (safety, natural and urban environment condition)

In both cities, the students from the schools near nature had lesser problems conducting outdoor activities, while the students from schools located in denser urban areas marked more varieties of problems while conducting OA. In Lahti, the cold weather has been reported as the most crucial problem by students, while in Dhaka, lack of safety, air pollution, and transportation problems are the main issues negatively affecting OA. Moreover, the preference for access to nearby green areas was the highest for future facilities, indicating the current management issue of openly accessing existing green areas and the lack of open spaces.

Usage of Nearby Public Areas for Outdoor Education (OE)

Lahti	**Dhaka**

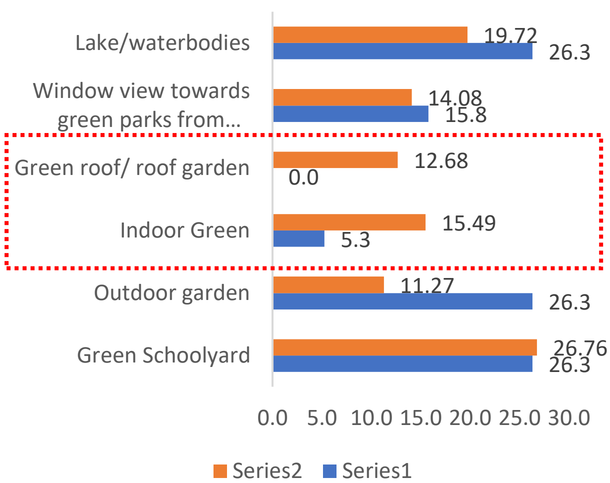


Figure 46 Usage of nearby public areas for OE, Lahti, Series1- School A, Series2- School B

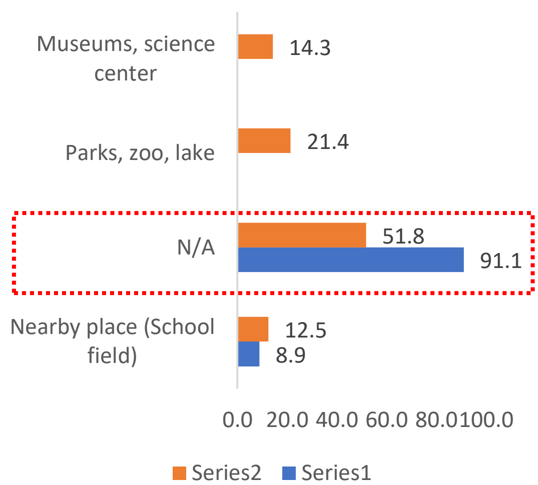


Figure 47 Usage of nearby public areas for OE, Dhaka, Series1- School C, Series2- School D

The outdoor Educational activity in Lahti is 'very high' in nearby nature usage. While in Dhaka, the school fields and museums are being used for OA. The use of natural areas for

Education was mostly reported negative by students in Dhaka. In school C (91.1%), and school D (51.8%) negative responses. The usage of 'indoor green' and 'roof gardens' was found to be more in school B compared to School A in Lahti. The usage of indoor green might be linked to the difficulties faced during OA in cold weather reported by the students.

<u>Willingness of Outdoor Activities</u>

Lahti	**Dhaka**

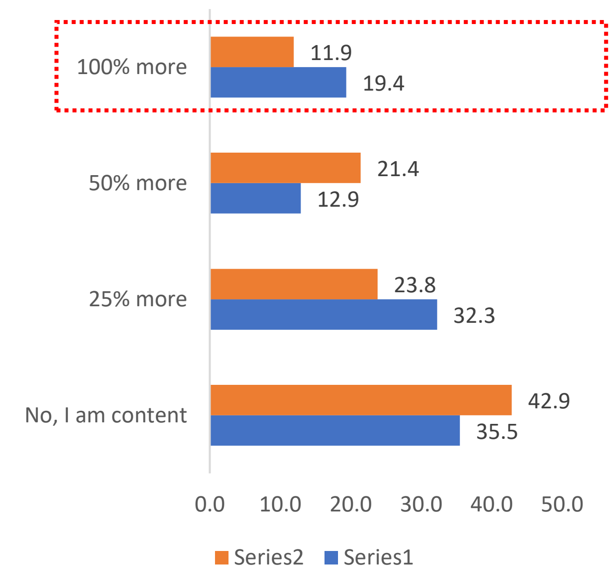


Figure 48 Willingness of OA, Lahti, Series1- School A, Series2- School B

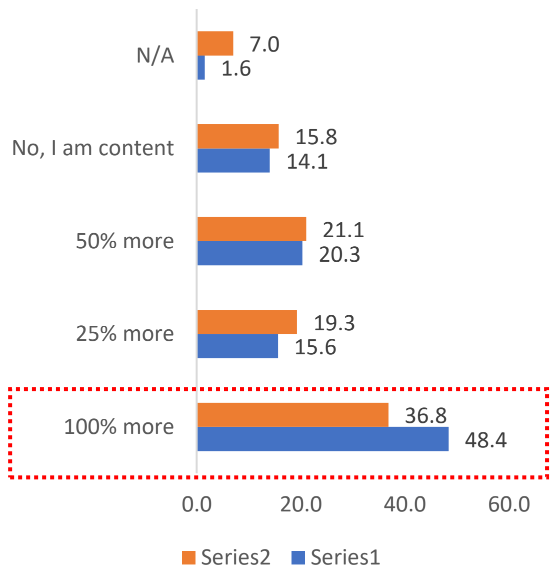


Figure 49 Willingness of OA, Dhaka, Series1- School C, Series2- School D

In both cities, the students from schools with close proximity to nature are content with current outdoor activities with the schools. On the contrary, the students from schools with less proximity to nature showed a higher percentage of willingness for 100% more outdoor activities.

Outdoor EEP willingness index in selected schools in Lahti, similar to equation (11):

$$\text{Willingness Index; } I_W = (f_p - f_n)/\text{n} \qquad (12)$$

= (44-29) / 73

= 0.21

Outdoor EEP willingness index in selected schools in Dhaka,

= (98-18) / 116

= 0.69

In the comparison of the students' willingness index for more outdoor activities, Dhaka scored higher than Lahti. This explains the current lack or complete absence of outdoor activities.

4.3.3. Comparison of Natural Elements in Selected Schools

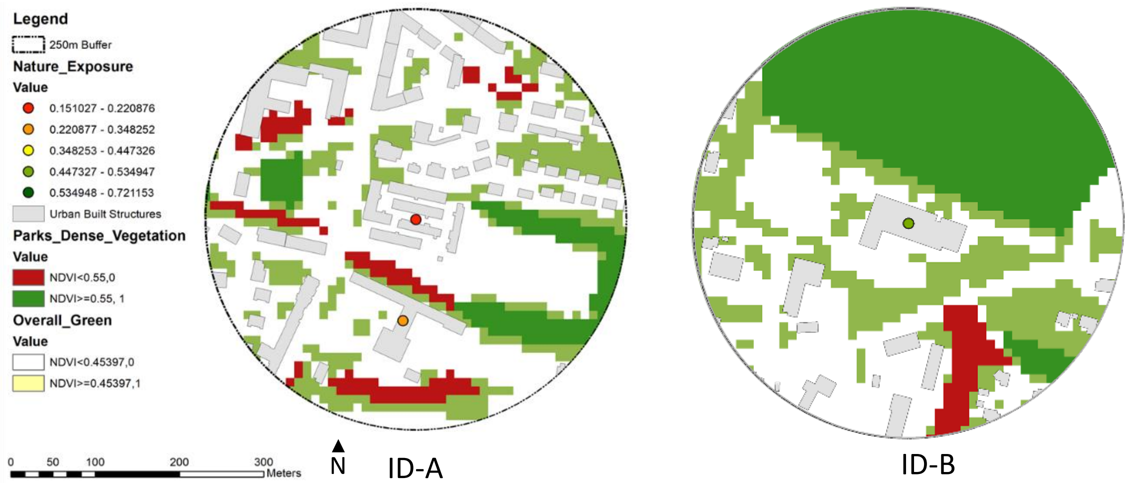


Figure 50 Exposure to Natural Elements in Selected Schools in Lahti

School ID	Distance to Parks (m)	Overall Vegetated Area, NDVI>=0.45397 (sqm)	Parks Active Green (sqm)	Distance to Blue (m)	Blue Area (sqm)
B	58.0149	115700	68600	1046.571	0
A	178.2827	15100	1600	1286.54	0

Table 9 Oberall exposure to nature in schools in Lahti

Figure 51 Exposure to Natural Elements in Selected Schools in Dhaka

School ID	Distance to Parks (m)	Overall Vegetated Area, NDVI>=0.45397 (sqm)	Parks Active Green (sqm)	Distance to Blue (m)	Blue Area (sqm)
D	84.67	90100	0.00	124.63	2600
C	267.75	10900	0.00	310.53	0

Table 10 Overall exposure to nature in schools in Dhaka

School A and B showed closer proximity to nature in comparison with schools C and D. In Dhaka, despite the school D showed a high amount of green area (NDVI>=0.45397), those areas are not publicly accessible parks areas. Moreover, the existing park within the 250m buffer of School D showed a very less amount of trees with active green NDVI value (>=0.55) as detected in the city's dense green areas. For the schools in dense urban areas in Dhaka, there isn't any open green area within the 250m buffer. In Lahti, in both schools, there are parks and open green areas within the 250m buffer of the schools. However, school A with a denser urban built-up context showed a higher amount of areas with less active green tress (NDVI<0.55).

4.3.4. Comparison of Urban Environmental Stressors in Lahti

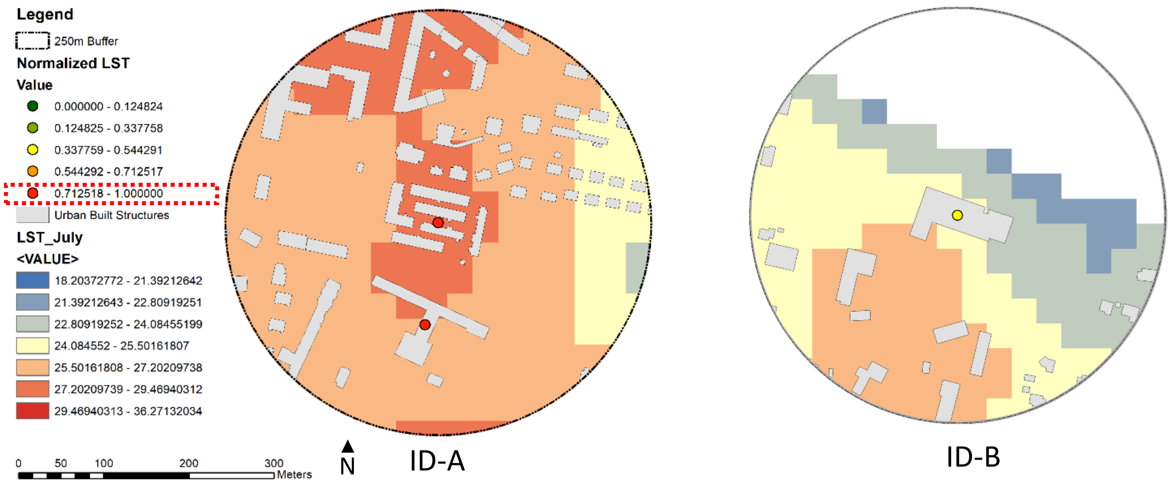


Figure 52 Summer Land Surface Temperature (LST)

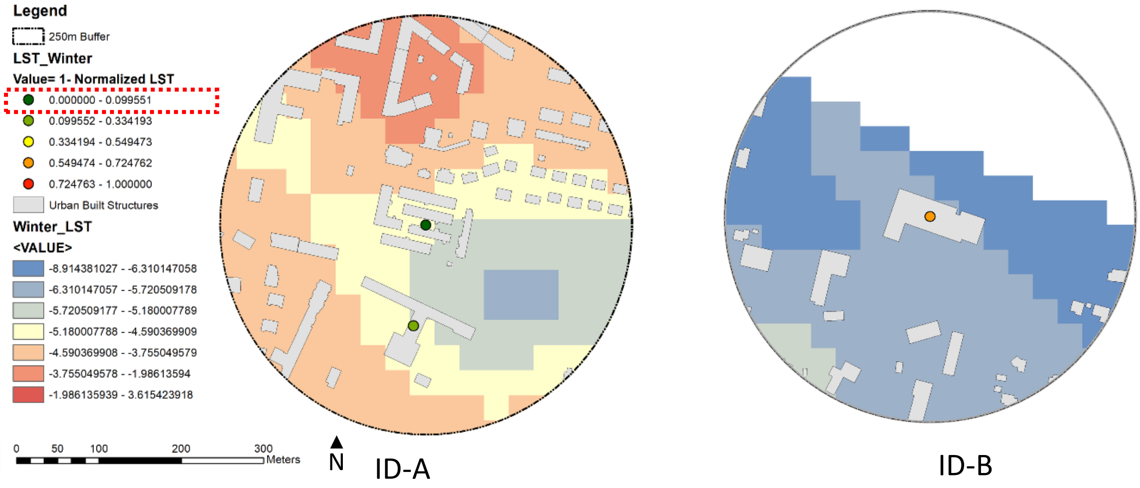


Figure 53 Winter Land Surface Temperature (LST)

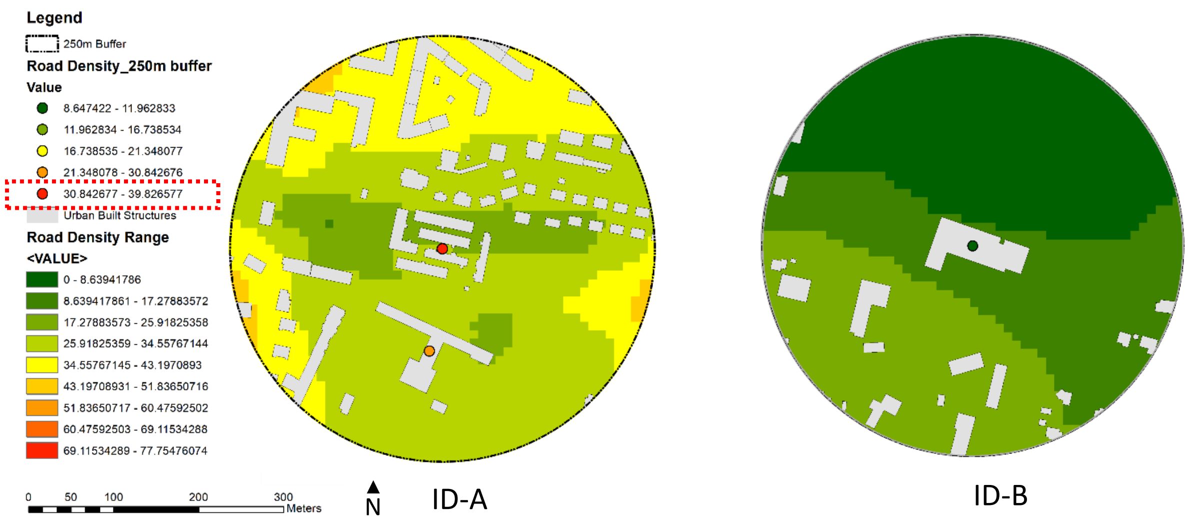


*Figure 54 Road density area within 250m buffer (Road Density Area= cell * 100)*

School ID	Road Density (Sqm)	Mean LST_July2020 (℃)	Mean LST_March2020 (℃)	Normalized Urban Environmental Exposure (E)
B	1196.28	24.68	-6.20372	**0.41**
A	3672.01	26.48	-4.09679	**0.56**

Table 11 Overall exposure to urban stressors in selected schools of Lahti

The values of the selected urban stressor indicators have been normalized for 31 schools in Lahti and averaged to calculate overall urban environmental exposure. School A, located in the densely built-up area, showed a higher exposure value of 0.56, and school B in the suburban location showed a lesser value of 0.41. School A falls within the 'very high' category of 'high land surface temperature' considering LST calculation in July 2020, (summer season), while it falls within the 'very less' category of 'low land surface temperature' in March 2020, (winter season).

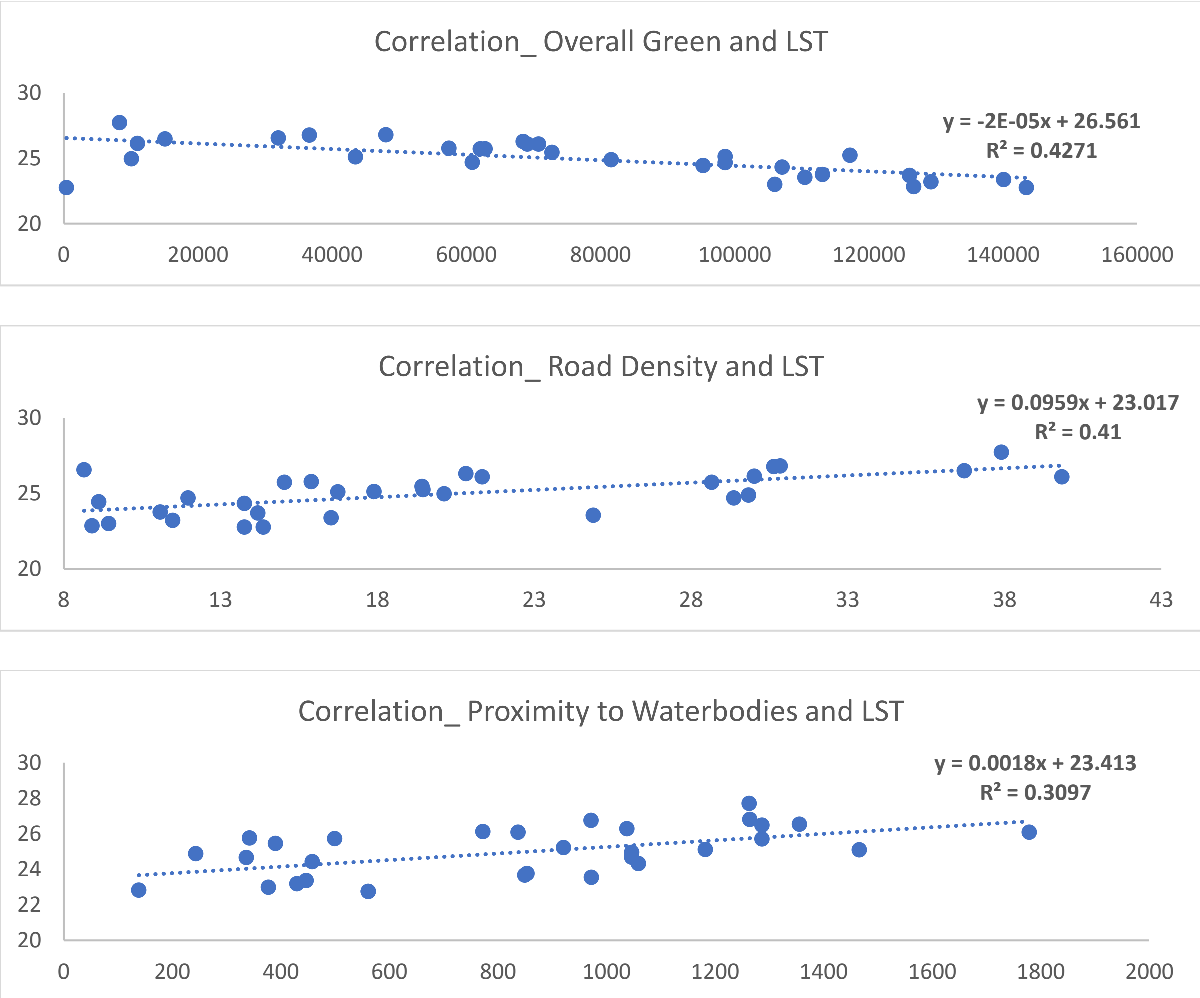


Figure 55 Regression analysis of the considered natural and urban environmental stressor indicators

Regression Analysis

A strong linkage between higher exposure to urban stressors and lesser willingness for outdoor activities or pro-environmental behavior has been found from the analysis. The normalized value of all the 31 schools in Lahti has been calculated considering the selected urban stressors. Amongst all the considered factors for natural and urban environment exposure, 'Overall Green within 250m buffer', 'Road Density' and 'proximity to Waterbodies' were the strongest with an R-value of 0.66, 0.64, and 0.56 respectively. *(Figure 55)*

4.3.5. Comparison of Urban Environmental Stressors in Dhaka

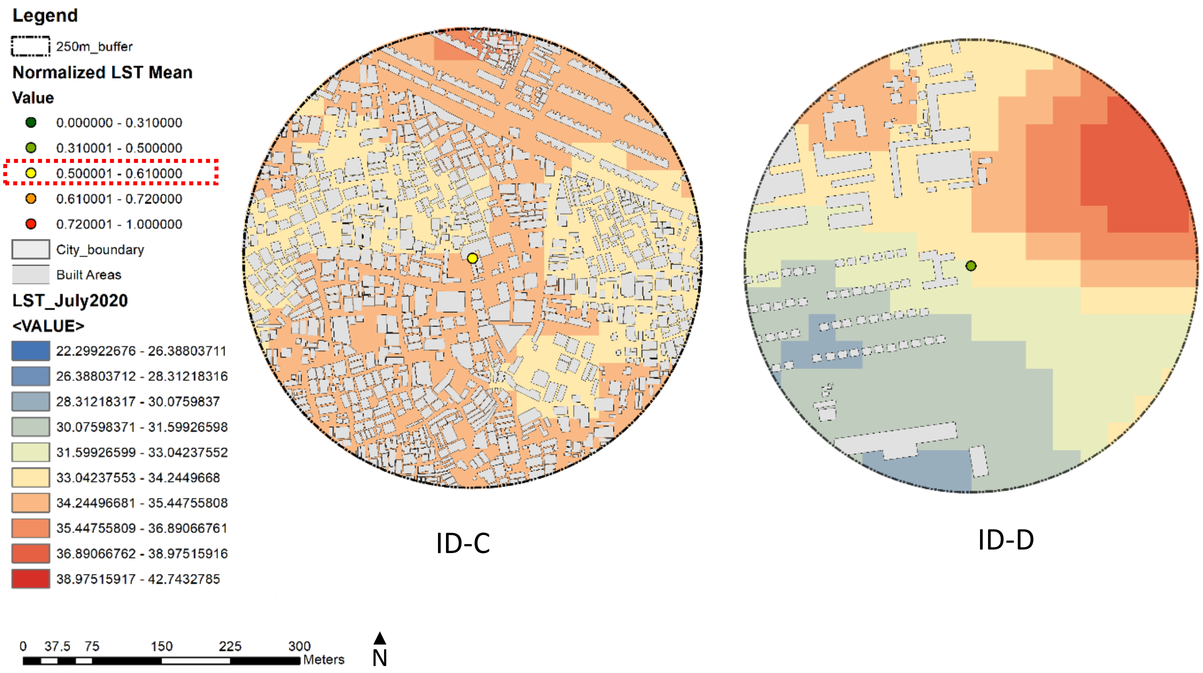


Figure 56 LST within 250m buffer of Schools during Summer (July 2020)

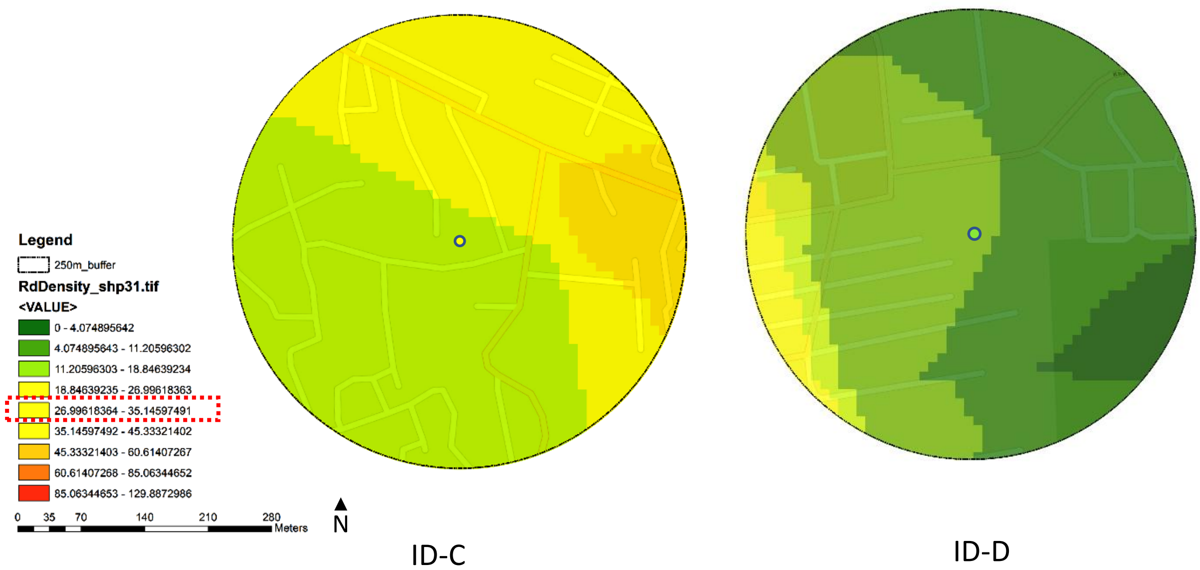


*Figure 57 Road density area within 250m buffer (Road Density Area= cell * 100)*

School ID	LST (Summer) (℃)	Road Density (sqm)	Normalized UE Exposure (within 324 schools)
C	34.4	2762.50	0.425615
D	33.06	1171.00	0.263029

Table 12 Overall exposure to urban stressors in selected schools of Dhaka

The values of the selected urban stressor indicators have been normalized and averaged to calculate overall urban environmental exposure. The school located in the denser urban area, C, showed a higher exposure value of 0.42 compared to school D located in a greener location (0.26). School C shows 1.36ºc higher land surface temperature compared to school D.

4.3.6. Discussion on Key Findings

i) Neighbourhood Nature and Adolescents Behaviour Relation

The comparison contributes to understanding contextual differences affecting outdoor activity willingness and pro-environmental behaviour amongst adolescents. From 'proximity to green' analysis results, 100% of schools in Lahti are within 250m distance of local green, wherein in Dhaka, only 28.7% of schools have parks or local green areas within 250m distance. However, despite the existence of nearby parks, the dense built-up of the city creates a visual and physical barrier between the schools and the open spaces. As explained by *(Wolsink 2016; Jenks et al., 1996)*, the urban densification concept regularly creates pressure against the preservation of local green areas. Even though Dhaka's dense built-up is not a result of conscious planning for less energy consumption, it has to do with unawareness, poor planning strategies, budget restraint for infrastructure development, and corruption. The findings from the students to have 'never' conducted any outdoor activities with the schools shows the alarming situation of 'Indoor Based Education.' The students to have never undertaken any outdoor activities also showed lesser pro-environmental behaviour and disconnectedness from outside nature. This finding aligns with the research findings of Formal Education in schools and universities, isolating the students from the immediate context of community life (Gruenewald & Smith, 2014) and lack of sense of 'Place' as stated by *Alan Gussow* in his *Artist-in-Residence for Mother Nature (1974).*

Moreover, the walking tendency amongst students was higher in the close green proximity schools in both cities. The lesser willingness for walking aligns with the research findings of green areas stimulating willingness of physical exercise like walking and social contacts *(Cohen et al. 2007; Roe and Aspinall 2011).* Again, proximity to the outdoor activity area correlates with lesser complaints about outdoor activity equipment and management problems mentioned by students in Lahti. More complaints related to performing outdoor activity can indicate less willingness caused by 'experience' of outdoor activities explained by *Wolsink (2016).*

Proximity and amount of green indicate a strong association with resilience development against pandemic situations amongst the schools. During COVID-19, the schools in Finland managed to continue educational activities through a combination of outdoor area-based and online media-based learning. More specifically, the less green proximity school students reported increased outdoor educational activities during the Covid-19 period. The adaptive capacity of the schools in Lahti during Covid-19 indicates the relation to the availability of accessible nature within 250m distance of the school. On the other hand, schools have been closed since March 2020; despite government and educators' attempts to bring the students back to school premises maintaining social distancing, finding 'enough' space outdoor has been the most crucial problem. The inability to cope with the Covid-19 situation reconfirms the necessity of open school premises and greeneries within proximity of schools for an effective and resilient Education system. This finding adds more importance to the results on the school ground and greeneries within 250m buffer being more effective than distant green by *Kuo et al. (2021)* and *Kuo et al. (2018b).*

In addition to proximity to green being necessary for frequent visits, 'overall greenness within 250m buffer' showed a stronger correlation with thermal comfort in both cities. Moreover, Lahti and Dhaka students' responses showed that thermal comfort plays a significant role in adolescents' willingness for Outdoor Educational activities. While in Lahti, cold temperature is causing unwillingness for OEA, in Dhaka, the hot temperature and lack of shading are causing the problem for OEA. The strong correlation of overall greenness with thermal comfort indicates that more greening and tree cover within 250m buffer can increase students' willingness to OEA in a hot climate city.

Multiple researchers such as *Akpinar, 2016; Akpinar et al., 2016; De Vries et al., 2003; Maas et al., 2006; Ord et al., 2013; Richardson et al., 2010; Richardson and Mitchell, 2010; van den Berg et al., 2007; Vujcic et al., 2018; Wyles et al., 2019,* have stressed on 'Quality' of green spaces over 'Quantity' to be strongly related to health, well-being, and Educational performance. However, the findings from this research show that on a neighborhood scale, the quantity of green space is also equally important for health, well-being, and stress reduction.

ii) Urban Environmental Stressors and Adolescents Behaviour Relation

LAHTI

The Suburb school in Lahti shows around 1.8ºC lesser land surface temperature in both summer and winter months cases. The LST difference strongly aligns with the suburban school students complaining more about the cold temperature as a problem for OA. (see Figure 41). Moreover, the finding of more indoor green and roof garden usage for outdoor activities in the suburban school of Lahti indicates the school's measures for adapting Environmental Education activities in extreme weather.

However, the percentage of students facing 'no problem' was also high in school B. In contrast, the urban school students mentioned various problems such as 'carrying types of equipment,' 'clothing problem.' No complaints about 'clothing' or 'carrying equipment' indicate that suburban school students are more resilient against extreme temperatures and don't face problems of taking equipment to distant places as urban school students. Furthermore, the road density in urban school neighborhoods shows 2500sqm more area than suburb school neighborhoods. Lesser road density can potentially link with the 9.8% higher walking tendency amongst suburb school students, and higher road density might relate to the 10% higher car usage amongst urban school students.

DHAKA

School D shows 1.34ºC lesser land surface temperature than school C, which strongly aligns with the students from School C preferring shading more than students from school D (see Figure 43). Lesser willingness for walking can link to heat exposure and lack of shading. The mention of problems related to 'Safety and Comfort,' 'Environmental Pollution (dust, dirt, poor air quality), 'Transportation Problem' was higher amongst students from school C, which indicates higher urban stressors exposure. Again, the percentage of students facing 'no problem' was highest amongst students from school D.

The road density within school C neighborhood is higher than school D (1591 sqm more), which can link to the 20% higher walking tendency amongst students from school D. Reducing road density by dedicated routes for non-motorized vehicles such as rickshaws, bicycles. Also, shaded pedestrian development with roadside greening can significantly positively impact walking behavior amongst students and enhance the local environment.

Critical Urban Environmental Stressors Affecting Adolescents Behaviour

The findings also contribute to the research gap of identifying which parameters of the urban built environment can directly or indirectly affect EEP establishment. The critical urban stressor elements affecting adolescents' behaviour towards OA are as follows:

1. Thermal Comfort

The strong correlation between overall greenness within a 250m buffer and Land Surface Temperature indicates that vibrant greenery at the neighbourhood scale significantly impacts thermal comfort. In addition, the amount of overall green strongly is associated with lesser complain about environmental issues such as dust, dirt, therefore, more willingness for OEA.

2. Road Density

Higher road density might potentially cause lesser willingness of walking behaviour amongst students. Specifically in Dhaka, lesser walking tendency and less comfort of OEA are more associated with lack of safety feeling and noise problem addressed by students from school C with higher road density.

3. Environmental Pollution

Contextual differences can lead to additional barriers against willingness for outdoor EEP. Environmental problems such as poor air quality, dust, and waste problems (dirty roads) can be significant issues while conducting outdoor activities, along with lack of safety and comfort. Again, lack of 'safety feeling' is also connected to the lack of visual and physical accessibility to the existing open areas and lack of management.

4.4. Section 4

4.4.1. School Criticality Index (SCI) for Contextualizing EEP

Findings from section 3 indicate a strong linkage of exposure to 'urban environmental stressors' and 'natural environment' with student's willingness for more or less active or outward engagement. Therefore, for considering EEP establishment in any city, considering current

environmental conditions of the schools can be the initiating point for understanding what kind of EEP can be most suitable for any specific context. Therefore, vulnerability assessments of the schools based on their locations for practical and contextualized EEP.
Following the central concept by *Chanbers, R, (1989),* 'external aspects' are land surface temperature (LST), road density, the scale of exposure (no. of students). The 'internal aspects' are contextual characteristics (porosity, effective wind flow height, wind shadow, and existing nature at neighborhood scale). Here factors related to urban built form, such as volumetric density or porosity, co-efficient of variation for effective wind flow height, and wind shadow, are grouped as inner qualities of the place. These parameters can not be altered easily and are affected by environmental exposures, considered the 'sensitivity.' Adaptive capacity is the group of natural indicators that impact EEP willingness positively.

Six indicators for adaptive capacity, three in both exposure and sesitivity have been considered for SCI calculation. Again, the values following zonal statistics within 250m of the 324 schools have been normalized following equation (2):

The simple average of the indicators following equation (3) forms each component of the criticality index. For calculation of SCI, equation (1) as stated before has been used:

$$\text{School Criticality Index, } I_{SC} = (Exposure, I_E - Adaptive\ capacity, I_{AC}) * \text{Sensitivity}, I_S$$

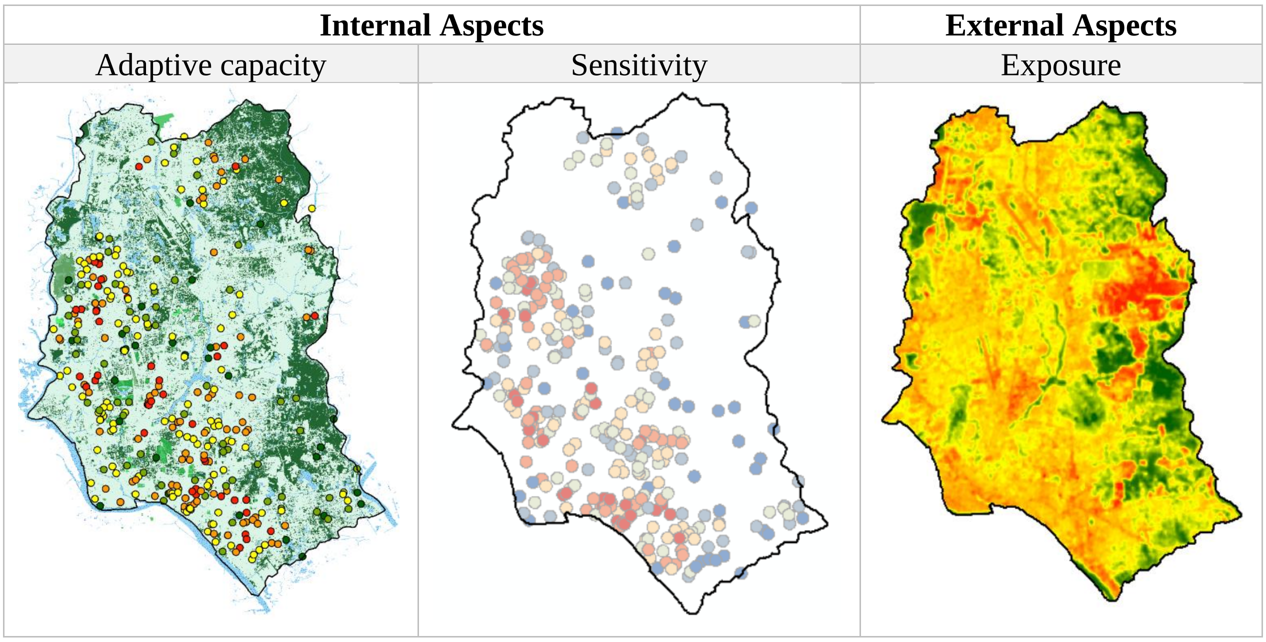


Figure 58 Three components of the proposed School Criticality Index (SCI) model

4.4.2. Identification of Critical Schools with Proposed SCI Model in Dhaka

Using the proposed SCI model in Dhaka, 42 schools from the 324 schools around the city showed 'high' to 'very high' in the criticality score index (SCI>=0.09). In comparison, 177 schools showed a medium SCI score (0.00=<SCI>=0.09). In Dhaka's context, the SCI value of more than 0 can be considered moderately critical in terms of existing nature, road density, and thermal comfort. Therefore, 219 schools fall within the 'Critical' category.

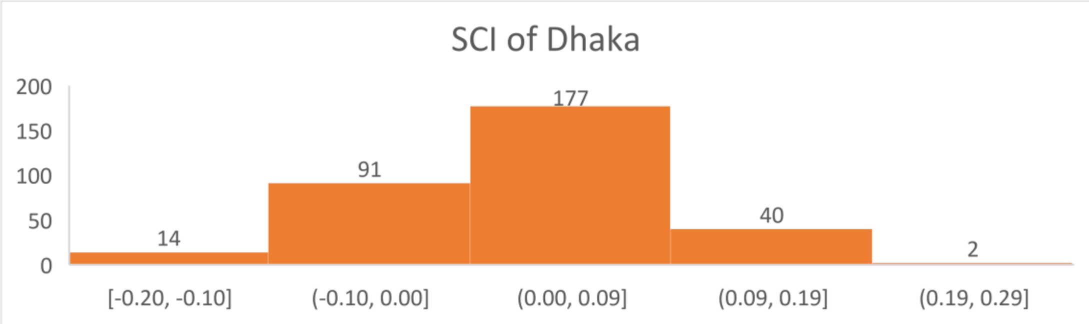


Figure 59 Distribution of SCI scores amongst 324 schools in Dhaka

The graph shows a normal distribution of critical schools with a minimum value of -0.2, a maximum value of 0.29. The average SCI score of the schools is 0.022, with a standard deviation of 0.069. It indicates the schools show lesser variability in SCI scores and higher resemblance within the contexts. (Figure 59)

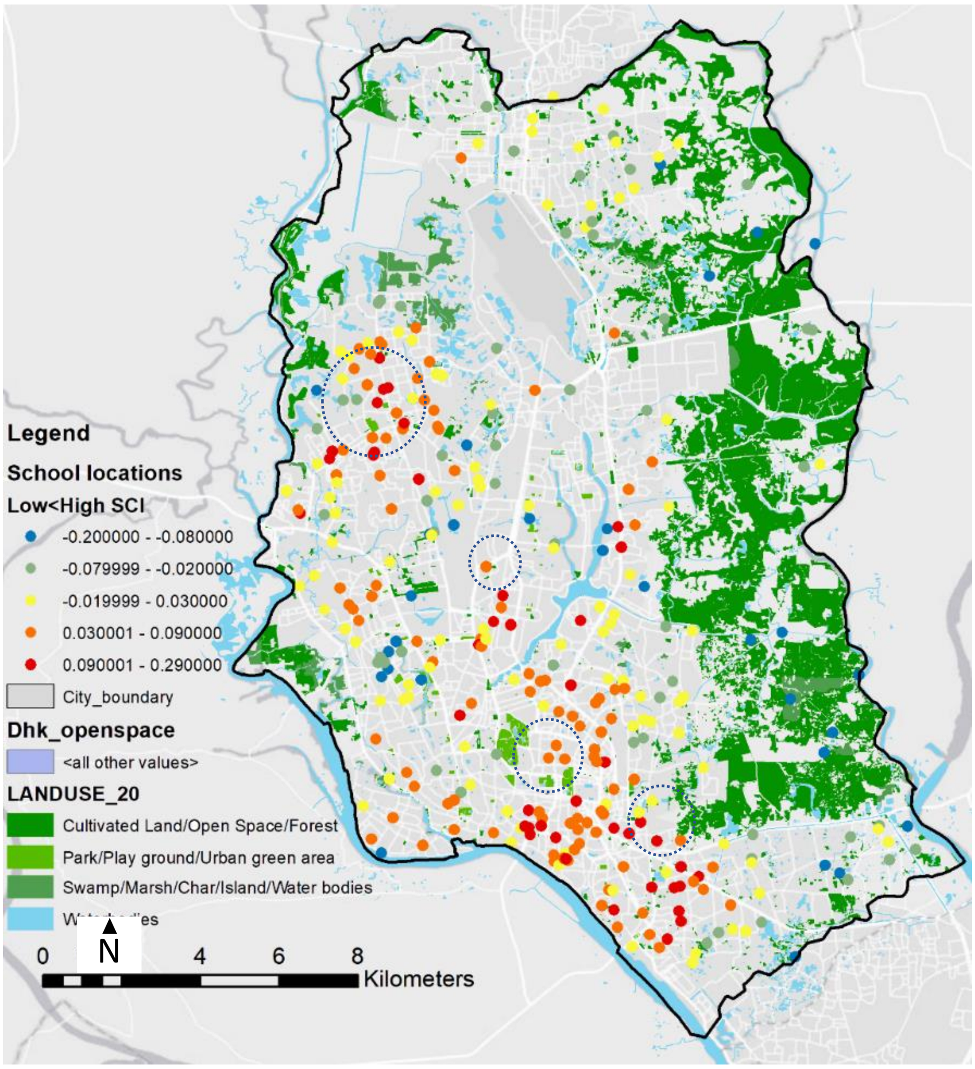


Figure 60 School Criticality Index (SCI) map of Dhaka City (ArcMap 10.6.1)

4.4.3. Relationship Between Proposed SCI Model and Environmental Parameters

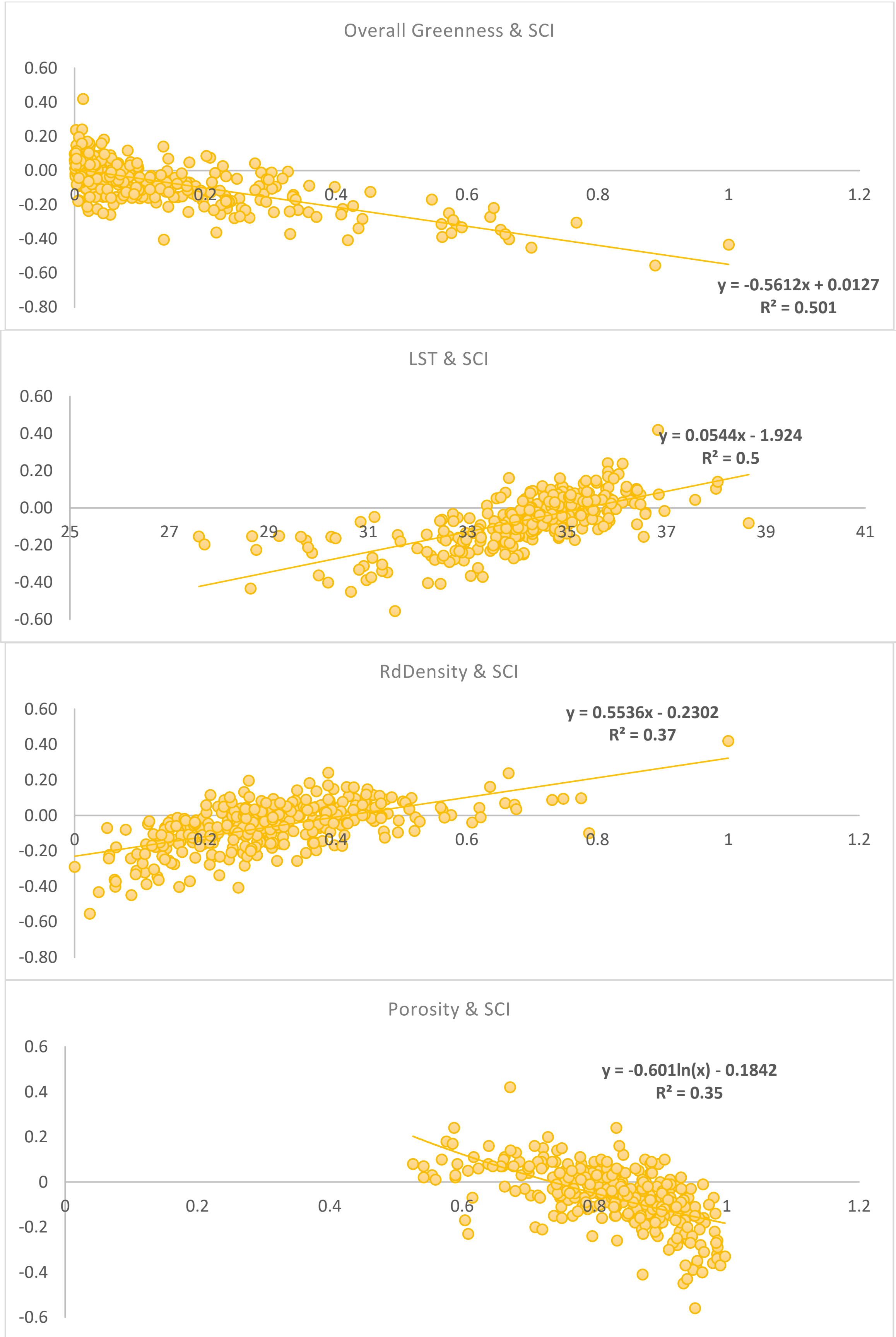


Figure 61 regression analysis amongst considered environmental parameters and proposed SCI scores

Summary:

- The scattered plot for Road Density and Land Surface Temperature (LST) shows a strong positive linear correlation with SCI scores, while overall greenness indicates a strong negative linear correlation. For porosity, the scattered plot indicates logarithmic relation with SCI score of schools.
- The scattered plot regression analysis indicates, amongst all the considered factors, overall greenness within 250m buffer (NDVI>=0.45397), LST, and road density showed a higher correlation with SCI scores.
- Considering there is a high correlation between overall green, it indicates that overall greenness increasing and road density decreasing can be significant for making the schools' surrounding environment less critical.

4.4.4. Averaged SCI Score of Schools Within Wards

The Ward-based map with the averaged SCI value indicates the wards with more urban environmental stressors and less natural environments within proximity of the schools. The results align with *Rahman et al. (2019)* for the environmentally critical area in DHAKA based on the green spaces, population density, and air pollutants, which indicates the SCI model can potentially identify schools within higher urban environmental vulnerable neighbourhoods.

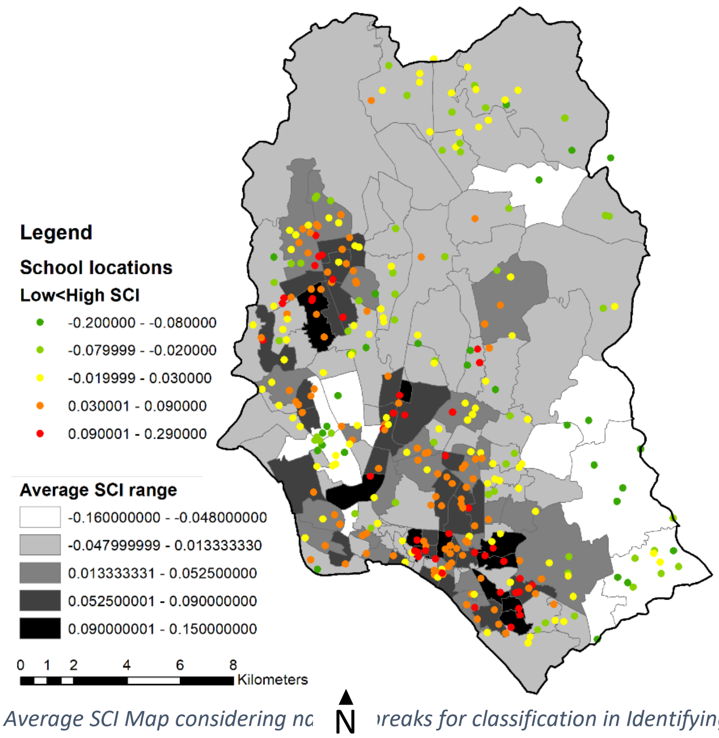


Figure 62 Ward based Average SCI Map considering nc ıreaks for classification in Identifying Wards with more or less crıtıcaı schools

Figure (62) illustrates that the number of schools with high SCI scores is higher than the ones in DNCC. However, this classification doesn't consider the uniformity of school numbers falling within each category. The proposed urban green management framework considers uniform school numbers and SCI scores falling within each class (use of Quantile function with five classes). Forty from the 55 high SCI scoring schools fall within the Dhaka South City Corporation area, specifically Old Dhaka, which shows that DSCC needs more GI-based intervention within school neighbourhoods.

4.5. Section 5

4.5.1. Proposed Urban Green Management Framework (UGMF) in Dhaka

High Priority Ward Identification for EEP Establishment

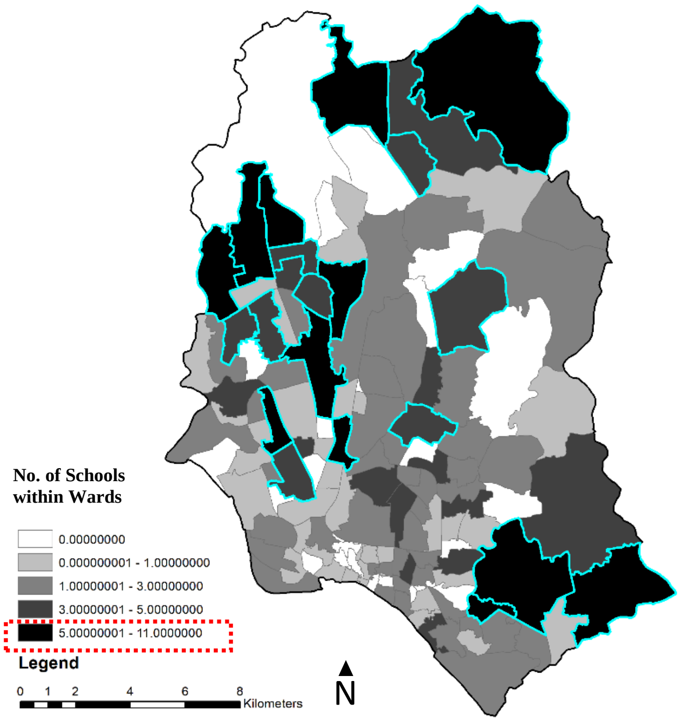


Figure 63 Map illustrating wards within 80th percentile of school number ranging from 5 to 11

The demonstration of the UGMF in Dhaka city shows that 20 wards in the city have schools more than 5 in number, that are distributed mostly in DNCC. (Figure 63)

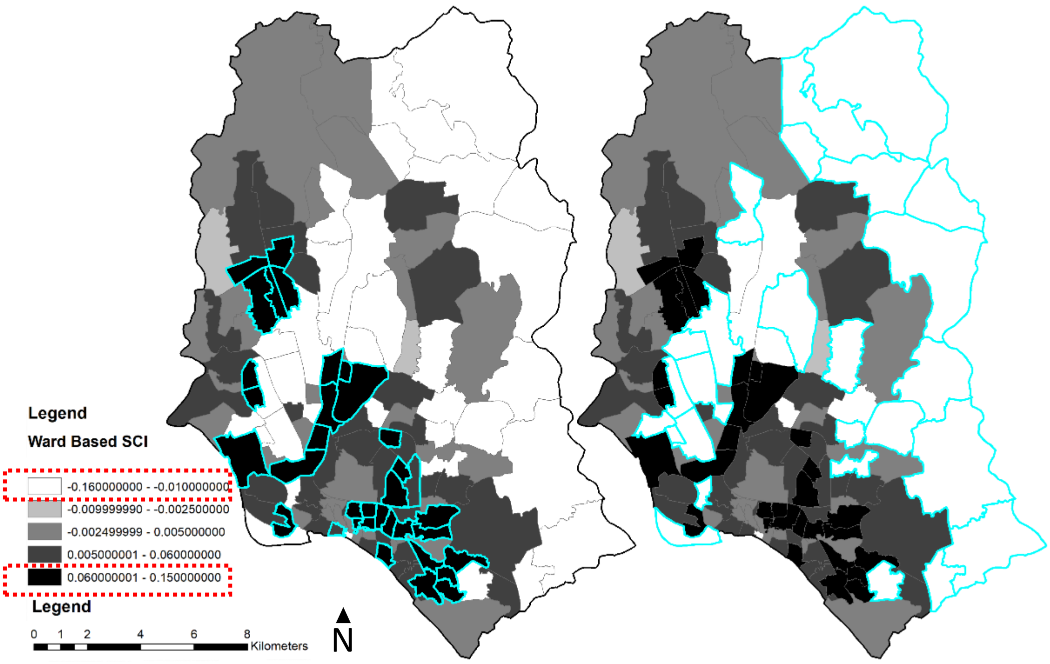


Figure 64 (i) Wards within 80th percentile of high SCI scoring schools (>= 0.06) for GI-based intervention. (ii) Wards within 20th percentile of high SCI score, therefore 80th percentile for least SCI score (<0.01)

Figure 64 (i) illustrates that the number of wards within the 80th percentile of high average SCI is 36, 26% of the total ward number. They are mainly located around the old Dhaka city, again aligning firmly with the findings from *Rahman et al. (2019)*, indicating that GI-based intervention is crucial in these areas to improve the local environment of the schools. On the other hand, Figure 64 (ii) shows wards within the 80th percentile of low average SCI are mainly around the eastern boundary, alongside the marshy lands. The marshy areas of Dhaka have gradually decreased from 32.5% to 17.2% within the years of 1960 to 2005 *(Dewan & Yamaguchi, 2008)*- this is due to encroachment by different residential and commercial area developers despite their high ecological importance. Twenty-six wards have been identified here from 138 wards (18.8%).

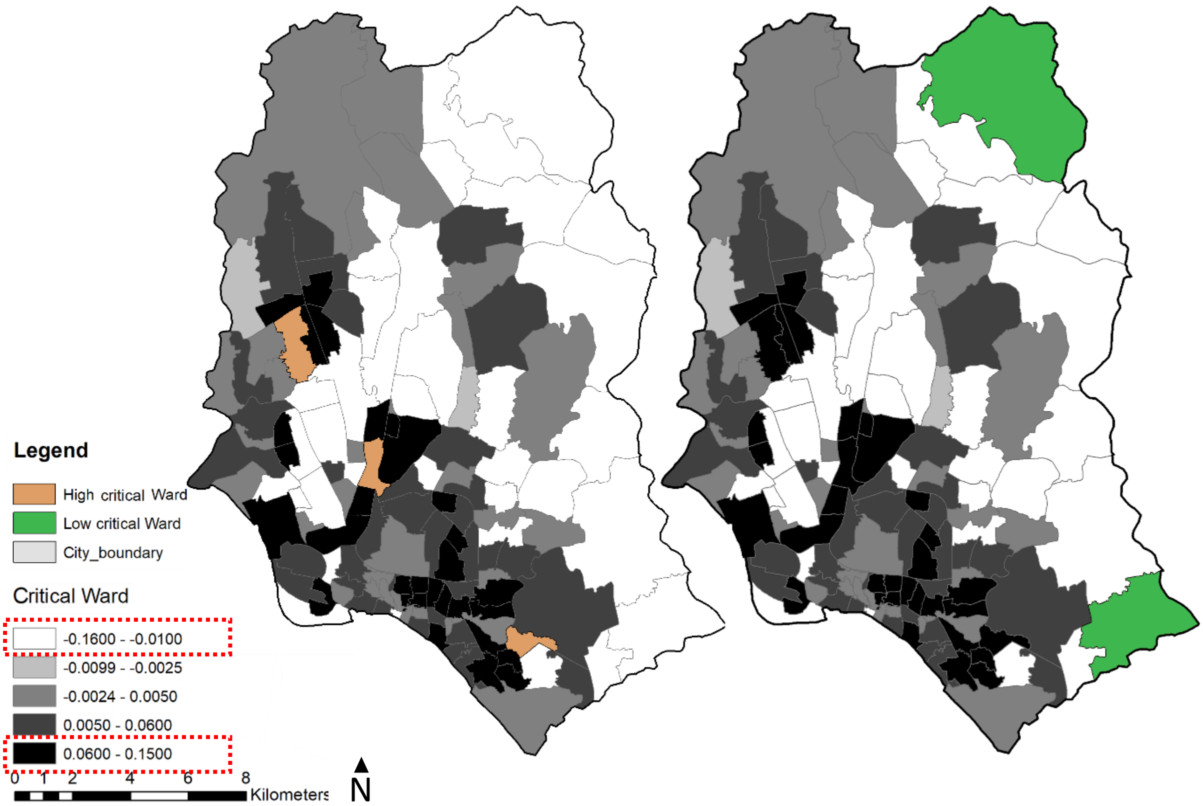


Figure 65 (i) wards within 80th percentile of high number of schools and high SCI score (no. >5 and SCI >= 0.06), (ii) Wards within 80th percentile of high number of schools and less SCI score (no. >5 and SCI <= -0.01)

Figure 65 (i) illustrates the three selected high critical wards with 80% of the schools lacking green infrastructure within 250m buffer, indicating GI installment for EEP establishment is necessary here. Figure 65 (ii) shows, the two resultant wards within the 80th percentile of a high number of schools and less SCI score (no. >5 and SCI <= -0.01) indicates the potential for outdoor-based EEP.

4.5.2. School Neighborhood Specific Intervention for SCI Improvement

i) Greening within 250m

To increase the overall greenness within 250m buffer of the schools, view shed[12] analysis using ArcGIS has been conducted for both schools in Dhaka. The Viewshed analysis results show that school C has a narrow range of visual openness due to the dense built-up of the school neighborhood. The street adjacent to the school has most of the points for a visual connection with the school location, which stresses the importance of the 'green corridor' and school premise greening to enhance the local environment

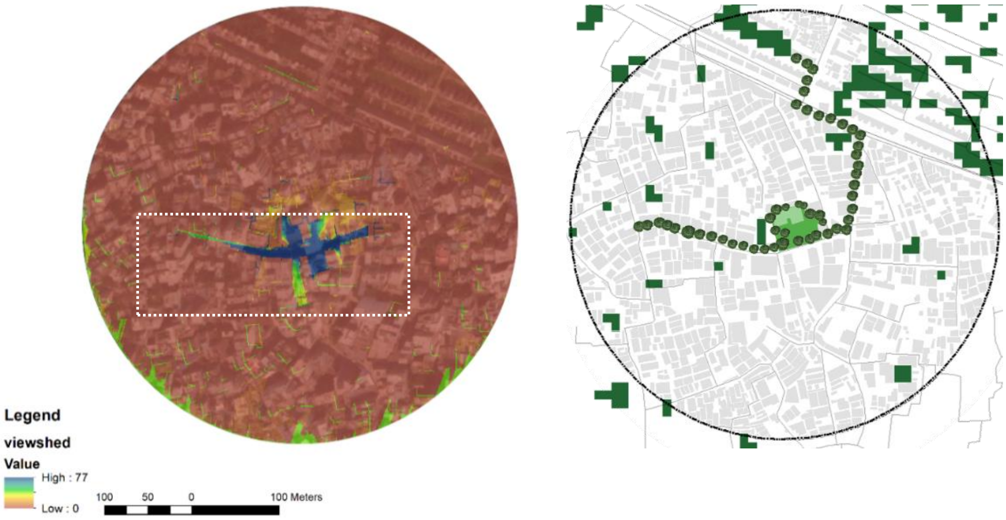


Figure 66 Green Corridor Development connecting with local green areas and School Premise Greening in School C, Dhaka

ii) Pedestrianization of School Adjacent Roads

High road density is strongly associated with students' responses about 'lack of safety and comfort' and 'lack of walking tendency.' Moreover, 'transportation' has been identified as a problem for conducting outdoor activities by the students, which refers to the long-distance and lack of continuous pedestrian and bike routes. Therefore, decreasing road density can be achieved by pedestrianizing the adjacent school roads and installing bike routes within selected wards as a primary intervention.

Current and Proposed Intervention SCI score in selected schools

Intervention Scenario	School Id	Exposure	Zonal Sensitivity	Adaptive Capacity	Adjusted SCI
Current situation SCI score	C	0.429491	0.59202	0.290023	0.082568
	D	0.261291	0.580409	0.470745	-0.12157
Proposed situation SCI score	C	0.328524	0.59202	0.305961	0.013357
	D	0.261291	0.580409	0.504088	-0.14092

Table 13 Current SCI score Vs proposed UGMF based scenario SCI score of two selected schools in Dhaka (Excel)

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[12] . 'A viewshed identifies the cells in an input raster that can be seen from one or more observation locations. Each cell in the output raster receives a value that indicates how many observer points can be seen from each location.' (Source: arcgis.com/).

For school neighborhood-specific intervention, schools premise greening with grass, planting trees considering at least 30% of the school fields and alongside the premise boundary, green corridor development with school adjacent road greening with trees, rooftop greening, and pedestrianizing adjacent road, show significant reduction in SCI for school C. It shows, simple intervention considering the school location and adjacent road can potentially reduce environmental criticality at the neighborhood scale. (Figure 66)

Prioritizing indicators for contextual improvement of schools from students' preference:

Adaptive capacity		**Exposure**		**Sensitivity**	
Indicator	Ranking	Indicator	Ranking	Indicator	Ranking
School Field Area	6	Land Surface Temperature	3	Normalized CV (lack of circulation/turbulance)	3
Proximity to Accessible Parks	5	Road Density (AQ, Noise) within 250m	2	Normalized lack of_ Porosity	2
Overall Greenness within 250m	4	Number of students	1	Normalized zonal windshadow	1
Active green/trees in parks within 250m	3				
Waterbody areas within 250m	1				
Proximity to Water bodies	1				

Table 14 Prioritizing indicators based on student's responses in local context for weighted average calculation of SCI (Excel)

Weighted Average of each Component, (Adaptive Capacity, Sensitivity and Exposure):

$$C_{WA} = \frac{\sum_{i=1}^{n} I \times W_n}{\sum_{i=1}^{n} W_n} \tag{13}$$

Here, w is the weightage of each indicator based on the ranking

I = Index of i^{th} indicator

Current and Proposed UGMF based 'Adjusted SCI' score in selected schools

Weighted SCI Scenario	**School Id**	**Exposure**	**Zonal Sensitivity**	**Adaptive Capacity**	**Adjusted SCI**
Adjusted SCI score	C	0.17	0.218351863	0.04991217	0.03
	D	0.12	0.195345097	0.084891571	0.01
Proposed situation SCI score	C	0.14	0.218351863	0.053453792	0.02
	D	0.12	0.195345097	0.09092115	0.01

Table 15 Adjusted SCI score considering weighted average of the parameters based on student's responses (Excel)

Even though the close green proximity school showed lesser criticality considering the simple average of the indicators, the adjusted SCI shows both schools in moderate criticality. The limitation of this calculation is that the indicators' value has been normalized, considering 324 schools following the same ranking of indicators. Furthermore, the other school student's perception analysis was not within the scope of this research. Therefore, the derived score reflects the selected two school student's perception of the neighbourhood environment only. Despite the limitations, the adjusted SCI score shows improvement, a decrease of 0.01 in SCI score, and a less green proximity school following the proposed UGMF.

4.5.3. Local Green Management Through EEP in Collaboration with Schools

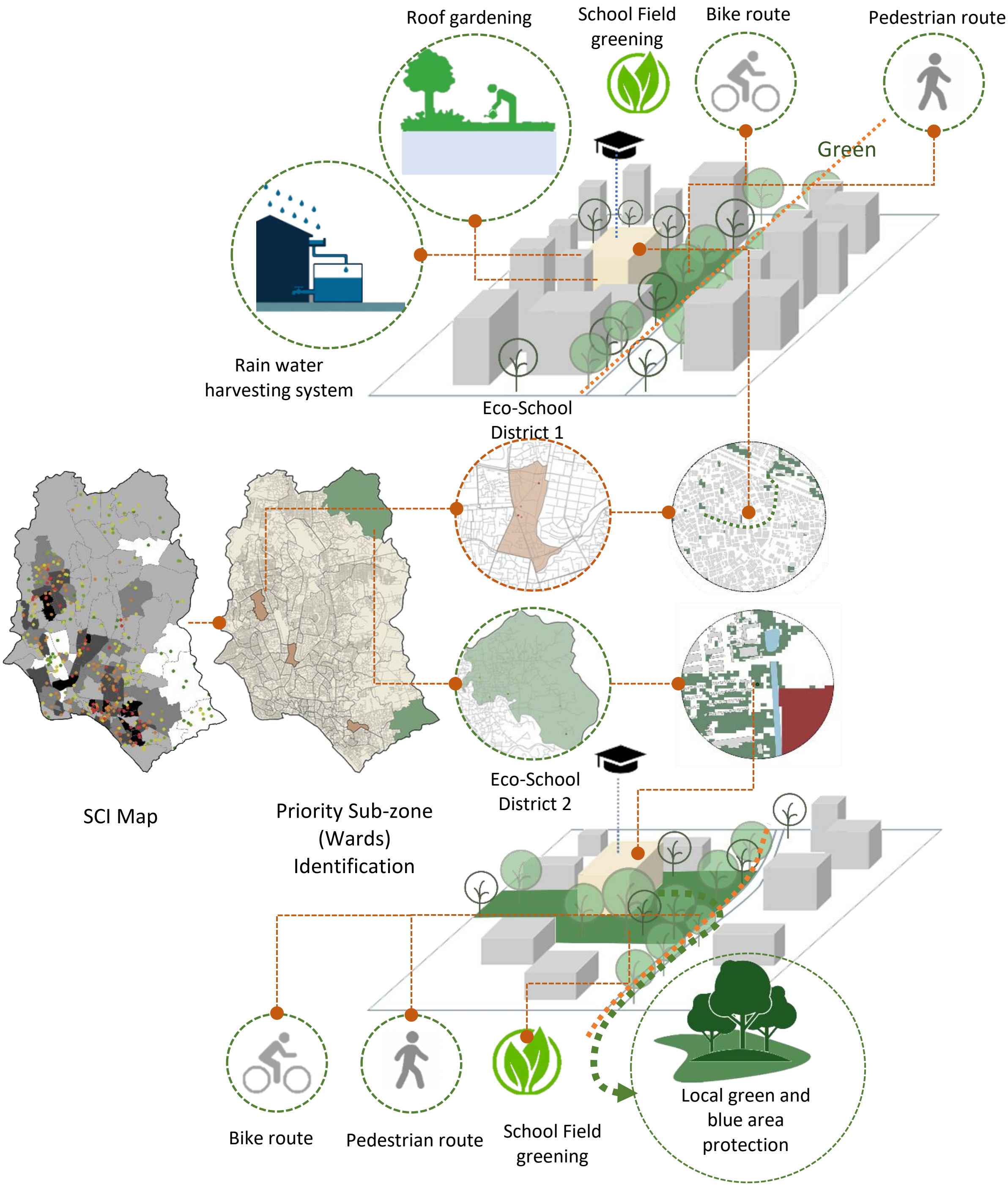

Figure 67 Wholistic Framework of Urban Green Management (UGM) Through Environmental Education Practice (EEP)

As shown in Figure 67, the wholistic UGMF based on the SCI model establishes a connection between nature preservation and the active participation of school students and the local community. The framework includes the initial idea of Eco-school district development and contextualized EEP based on the school neighbourhood requirement. It considers contextual EEP in collaboration with schools to address urban environmental issues at the city and community scale.

4.6. Limitations

The questionnaire surveys with the students were conducted online. The possibility to conduct the interviews or questionnaires in person was out of scope considering Covid-19 restrictions. Therefore, there were chances of questions being misunderstood by some students and also no scope for probing.

Environmental parameters have been derived from open data source & remote sensing data (Landsat 8 and Sentinel 2A). School location and building digital elevation data for Dhaka city has been validated only for the 250m buffer zones of the 324 schools by using Google earth. Buildings immediate outside of the 250m buffer hasn't been considered. Therefore, the simulation results considering the DEM and DSM with the validated data (wind shadow, view shed, wind effect) will not show accurate results immediate next to the 250m buffer outline areas.

Tree cover data within the parks were not available for Dhaka. Therefore, the mean NDVI value for sample tree cover areas inside the city has been considered for identifying the NDVI threshold. Sentinel 2A data with a spatial resolution of 10m x 10m has been used for calculating the NDVI map. Therefore, tree canopy cover/vegetation lesser than 100 sqm has not been detected in the resultant map for 'Dense vegetation within nearby parks'.

Effective wind flow height results were derived using annual mean wind direction, while this facilitates in deriving an overall effective airflow height, the same is not representative of the various seasons throughout the year. In other words, effective wind flow height and its corresponding influence on local micro-climate may vary seasonally.

The proposed SCI based UGMF considers classifications based on the calculation using normalized value of indicators of the selected city schools only. The resultant SCI values represents the relative criticality of the schools in a given sample. Therefore, the SCI scores of two different samples are not comparable.

CHAPTER 5: CONCLUSION

Environmental Education as a concept has been practiced in many countries for environmental awareness and sustainable lifestyle practices. Even though, the main concept is to make people aware of environmental challenges, knowledge on global scale regardless being aware of local context might not be an effective approach to Environmental Education establishment. This research contributes to the understanding of contextual or local environmental factors that can potentially trigger different environmental behaviour amongst adolescents.

The SCI model can be a silver lining in the debate of compact city and urban green preservation since it considers neighbourhood-scale greening and reconnects local green areas with schools for EEP in cities. Furthermore, the model promotes local environment enhancement through greening within 250m buffer of schools as the most crucial parameter for outdoor Environmental Education practice leading to better health and well-being of the students. The SCI based UGM framework combines the concept of Person-Environment Interaction Model (PEI) for pro-environmental behaviour development and elements of Attention Restoration Theory (ART) for positive impact on school going students. Connection with local green areas as idyllic places for 'Being away' and 'green corridor' as 'Trails' and 'Pathways' for extent is considered for vice-versa effect on dwellers and the environment (Kaplan, 1983). The model is a contribution to the research gap mentioned in chapter 2.5 about 'how' EEP based urban green management framework can contribute to local green management considering schools as a center for sustainable development.

For EEP establishment, the SCI based UGM framework allows policymakers to divide the city into multiple districts with similar schools with high or low SCI scores. 'Eco-Schools Districts' with similar average SCI can stress on common interventions and school specific interventions:

- School premise and school front road greening considering at least 30% of school premise with tree cover for increasing overall greenness of the school neighbourhood
- Protecting local green areas by active and frequent participation of adjacent school students and authorities, distant schools from neighbouring districts can become less frequent participants.
- Pedestrianizing school front road and tree plantation alongside the street to turn school front street canyon into the urban green corridor- an open space for interaction and activities for the students and community people
- Bike route and wide pedestrian route development starting from school neighbourhood scale for promoting biking and walking
- Energy-efficient, sustainable building equipment instalment in the schools (e.g., solar panel, water harvesting tank) to provide a real-time demonstration of sustainable lifestyles
- Providing training for people willing to become a nature guides and protectors of urban green areas

Recommendations For Future Research

The proposed School Criticality Index (SCI) shows 'how' school neighbourhoods can be evaluated for EEP establishment potential considering their respective morphology and natural elements. The extent to which the schools can enhance local climate following the proposed SCI model-based Urban Green Management Framework (UGMF) needs further research. This concept can proceed to future studies as proposed below:

Impact on School Neighbourhood Micro-Climate

- The study shows how SCI based urban green management framework can include school-specific interventions in neighbourhoods. Further research can focus on greening impact within the school premises and green corridor development on the local microclimate level.
- The Proposed framework stresses pedestrianizing school adjacent roads to enhance environment quality (e.g., Air Quality, Noise Pollution). Further research can focus on to what extent pedestrianization can enhance local climate.

Impact on Transportation System

- To what extent can the adjacent school roads pedestrianization reduce traffic congestion in school neighbourhoods on different critical occasions.

Impact on Urban Flooding

- The proposed Urban Green Management Framework (UGMF) stresses roof gardening, school premise greening, and green corridor development. To what extent proposed roof gardening can reduce urban flooding in the school neighbourhoods can be further researched.

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APPENDICES

Annex 1 Interview Questions & Responses, NatureScot

1. **Please tell us more about how did you get involved with Nature Scot? What is your role in the body?**
   - Academic background in ecology/ resource management with a Master's degree, and developed an interest in environmental education, and became employed in the informal education sector. Currently Outdoor Learning advisor (one of 2 p/t posts) in NatureScot previously ENFOR outdoor learning project post working across Scottish Government agencies; – much earlier I was an Area Officer for Scottish Natural Heritage in early 1990s. I have also worked outside of NatureScot in the outdoor learning/ environment third sector.
   - Current work supports Young People - Learning Outdoors and Developing Skills
   - I manage the Outdoor Learning Directory which signposts outdoor learning resources, research, funding, places to visit, and other news.

2. **What are the current activities by your institution in terms of outdoor education and access to public spaces/parks?**
   - Focus is on outdoor learning (outdoor education carries association with the outdoor activity sector which is more specialized). As capacity is limited we aim to support teacher practitioners (e.g. through training) rather than offer direct support to individual schools and classes (although also respond to individual enquiries when required).
   - OL advisors (2 x part-time staff) based within NatureScot's People & Places activity team which includes staff who support work around outdoor access, and Green Infrastructure.
   - Develop programs and resources to support place based OL and connection with nature under the Scottish Biodiversity Strategy Route Map – see Learning in Local Greenspace and Outdoor Learning in Nature fund

3. **Can you tell us about the administration system in the SNH?**

- How many staff members do you have related to the outdoor and nature preservation activities?
   - @ 500-600 across the organization as a whole? Areas of work covered are described here. We have around 35 staff in our People & Places activity.

- What are your target groups and by whom the services are provided? Do you have any volunteers? (how many?)
   - Target groups for education work is the education sector – teachers, partners, local authorities (32 across Scotland) and other stakeholders across Scotland. Fits with the Scottish curriculum ages 3-18.
   - Our National Nature Reserve staff are most likely to engage with volunteers

4. **How do you incorporate the following topics in your activities?**

- sustainability in general
   - in education in Scotland, outdoor learning is one of the 3 key strands for Learning for Sustainability. So by supporting outdoor learning in nature we are helping to support connection with nature & care for nature. We also encourage sustainable approaches to OL by encouraging outdoor learning on the doorstep of schools in their local greenspace, within walking distance, so supporting active travel with no carbon footprint.

5. **Are the local inhabitants aware of the activities? How are you incorporating the stakeholders (for instance: community people, students from different age groups, environmental educators, volunteers, educational institutes, national/international researchers etc.)?**
   - Depends on the project/ program. Learning in Local Greenspace encouraged wider community links – with a follow up evaluation in development. In future we would like to build in academic research at the inception of projects to track outcomes.

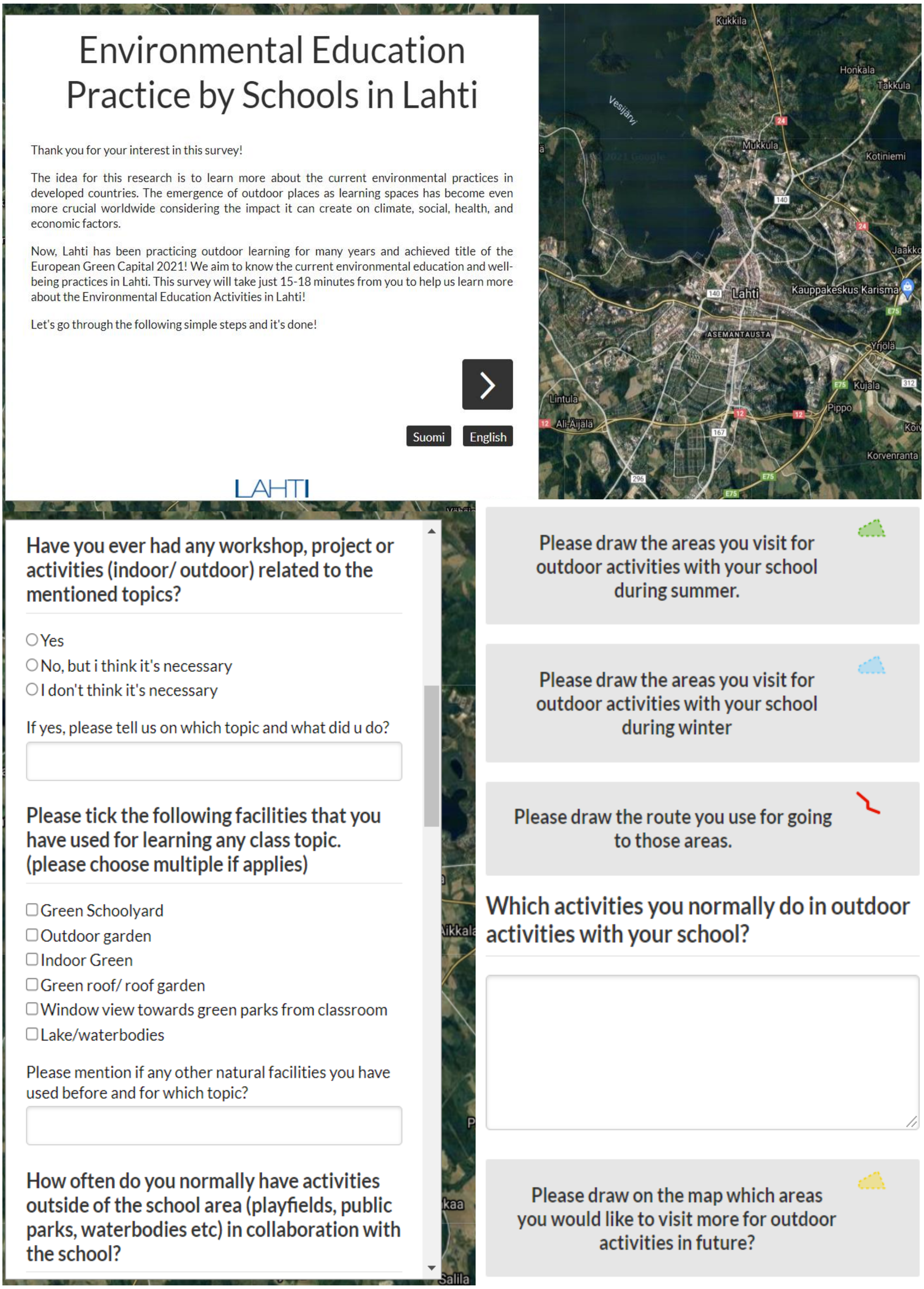
6. **How often do you involve the different communities in the activities? How do you consider the level of cooperation with communities at municipality level?**
   - Projects aims for whole school community approach. Often this is achieved through third sector partner links where we fund partners to support schools.
   - An example - if you are visiting Glasgow in future you might be interested to see the Seven Lochs project

7. **How do you monitor the existing green spaces and parks in the urban areas? Is the system incorporated with the outdoor educational activities? Are you content with the current situation?**
   - See Greenspace map for outdoor learning
   - Edinburgh City Council have developed an Outdoor Learning map (with NatureScot funding support)
   - Our funded projects have to submit regular funding reports to our grants officers. We evaluate projects – for example, teachers were encouraged to take part in a Survey Monkey evaluation of the Learning in Local Greenspace project at the start and end of the project to help to evaluate impacts (e.g. increase in teacher confidence in taking classes outdoors etc.)
   - Not content with the current situation no – would like to see outdoor learning in nature embedded as regular and frequent practice across all schools in Scotland. This is still patchy, although Scotland's education policy strongly supports outdoor learning with some excellent practice in some schools, and some local authorities (see East Ayrshire for example) .

Annex 2 **Interview Questions & Responses, Geoparks**

1. Please tell us about Your background and how did you get involved with Miyako Ecology Center? What are your roles and responsibilities within the centre?
- Can you tell us the background of your institution and what was initial aim of this institute? When was the institution founded and who is responsible for its budget?
2. How many people visit the center per month/ year? Is the amount increasing or decreasing?
- What age group the visitors belong to most? (kids/teenagers/ young adults/middle age/seniors)
- What is your expected outcome from the services provided to the different age groups? Do you customize the same content for different age groups or is it uniform for all?
3. What are the services you are providing?
- How many staff members are working in the institute and what kind of expertise they have?
- What kind of administration the center has? What are the key principles to follow in the organisation?
4. Do you provide training programs? If yes, who can access these programs?
- How long are these trainings? Is it weekly/ monthly/yearly basis training? How often the trainings take place?
- Do you give certificates and what advantages would that give to the participants in terms of getting a job?
5. What is the relationship between your center and formal education in Kyoto?
- How are you cooperating with the formal education?
- Are you content with the situation or would you like to change it somehow?
6. How do you consider the strengths and weaknesses of the current educational structure from your perspective?
7. Do you evaluate your impact on the population dealing for example recycling and environmental awareness?
8. How do you incorporate the local stakeholders?
9. How do you incorporate the following topics in your activities?
- sustainability in general
- waste management
- ecosystem services and green infrastructure
- circular economy
- renewable energy
10. How would you rank Japan in terms of environmental awareness compared with the rest of the world?
- Can you please elaborate more what Japan is doing well in terms of environmental aspects and what are the challenges that you are facing?
11. How do you see the current situation of energy production in Japan and what should be the role of renewable energy in the future?
12. Do you find that the institution has influence over the decision makers in terms of ecological/environmental/wellbeing policies?
- Since Finland as a whole, specially Lahti has the highest level for waste management and recycling facilities. And vice versa Japan has been way ahead in terms of water usage, would you be open to send delegates to learn more about some of the new technologies and processes, as well as host delegates from Finland to share your best practices.
13. What kind of international cooperation do you have? Do you often have international visitors and groups? Are your interested to develop this area further?

Annex 3 **Maptionnaire based Questionnaire with Schools in Lahti**



Environmental Education Practice by Schools in Lahti

Thank you for your interest in this survey!

The idea for this research is to learn more about the current environmental practices in developed countries. The emergence of outdoor places as learning spaces has become even more crucial worldwide considering the impact it can create on climate, social, health, and economic factors.

Now, Lahti has been practicing outdoor learning for many years and achieved title of the European Green Capital 2021! We aim to know the current environmental education and well-being practices in Lahti. This survey will take just 15-18 minutes from you to help us learn more about the Environmental Education Activities in Lahti!

Let's go through the following simple steps and it's done!

Suomi English

LAHTI

Have you ever had any workshop, project or activities (indoor/ outdoor) related to the mentioned topics?

- ○ Yes
- ○ No, but i think it's necessary
- ○ I don't think it's necessary

If yes, please tell us on which topic and what did u do?

Please tick the following facilities that you have used for learning any class topic. (please choose multiple if applies)

- ☐ Green Schoolyard
- ☐ Outdoor garden
- ☐ Indoor Green
- ☐ Green roof/ roof garden
- ☐ Window view towards green parks from classroom
- ☐ Lake/waterbodies

Please mention if any other natural facilities you have used before and for which topic?

How often do you normally have activities outside of the school area (playfields, public parks, waterbodies etc) in collaboration with the school?

Please draw the areas you visit for outdoor activities with your school during summer.

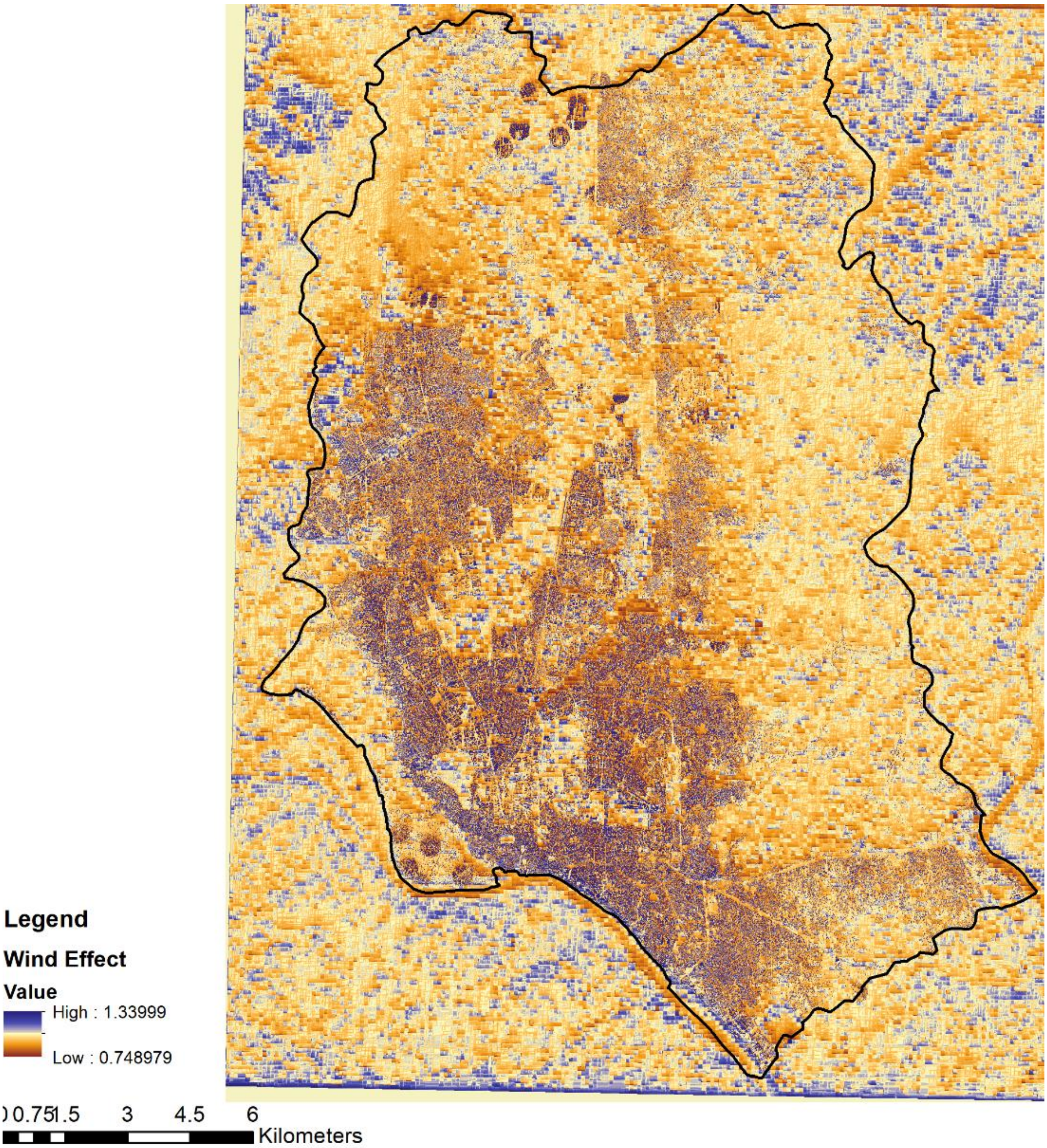
Please draw the areas you visit for outdoor activities with your school during winter

Please draw the route you use for going to those areas.

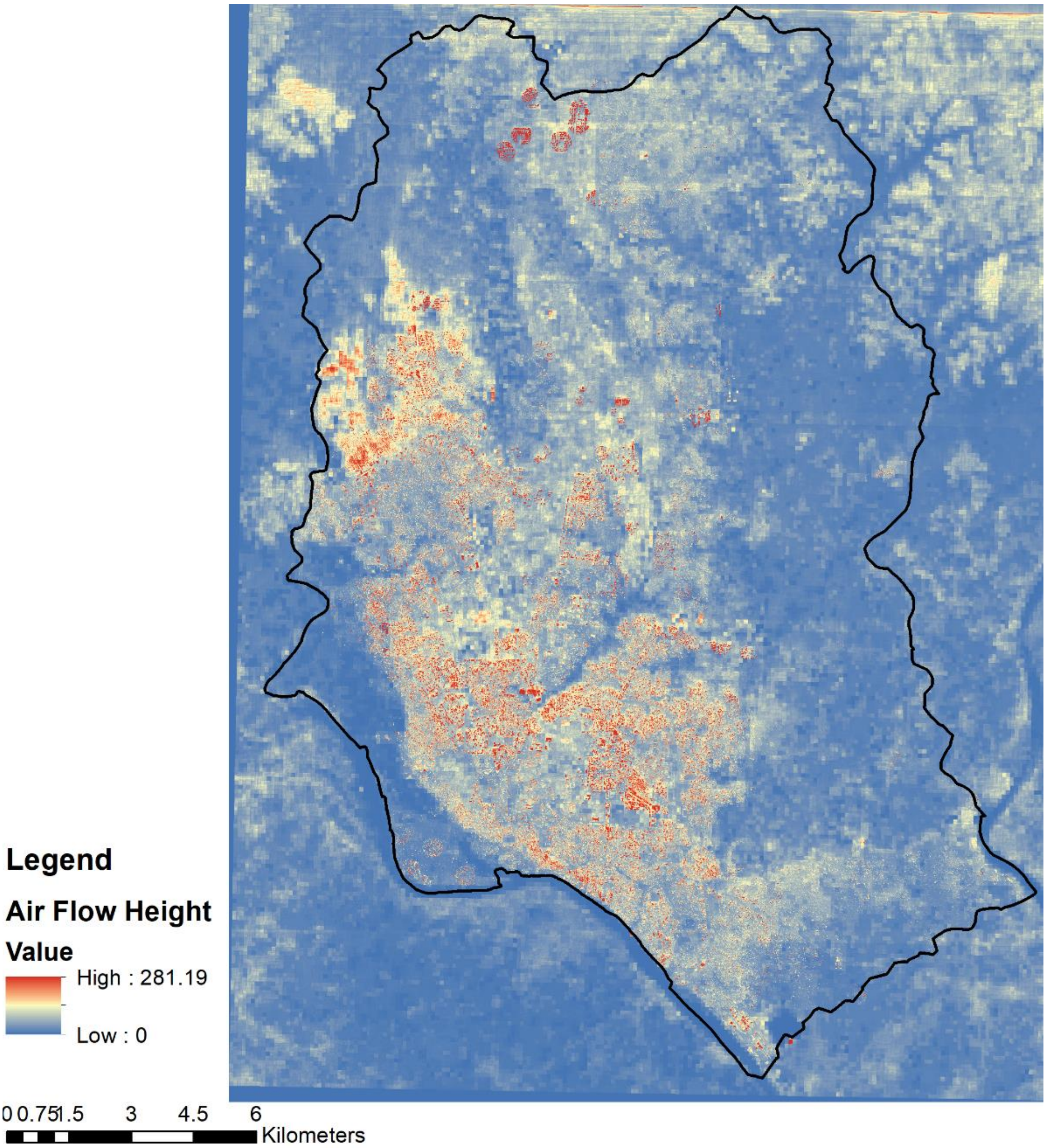
Which activities you normally do in outdoor activities with your school?

Please draw on the map which areas you would like to visit more for outdoor activities in future?

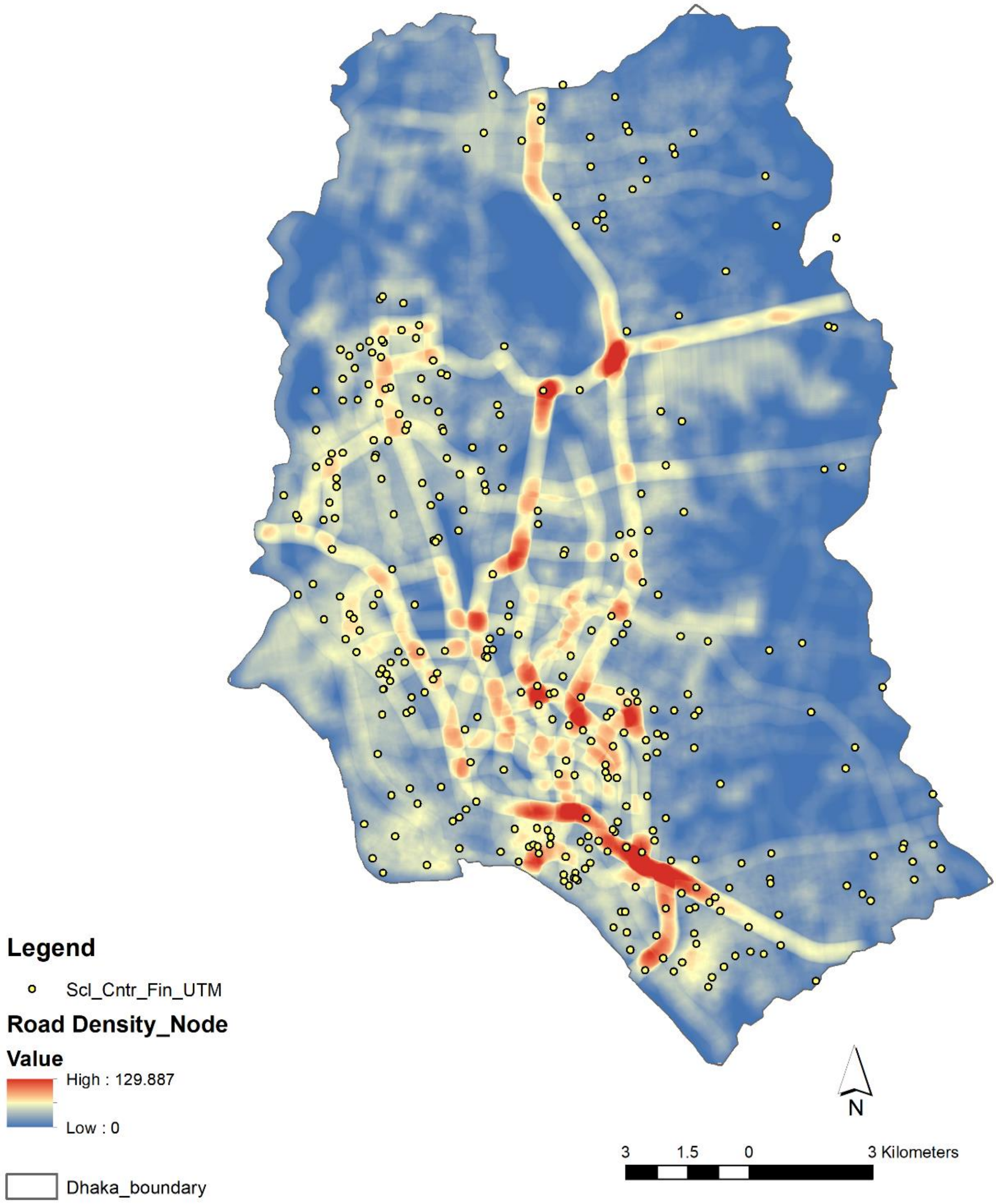
Annex 4 **Wind Effect Analysis Using Saga GIS**



Annex 5 **Effective Air Flow Height Analysis Using Saga GIS**



Annex 6 **Road Density Analysis Using ArcMap 10.6.1**



Annex 7 **Normalization of derived values for SCI calculation**

Normalized Active Green in Nearby Parks Area (3)	Normalized Vegetation Area (4)	Normalized Distance_Parks (5)	Normalized Distance_Blue (1)	Normalized Blue Area (2)	Normalized Actual Field Area (6)	Normalized CV (Atmospheric Stability)	Normalized lack of_ Porosity	Normalized zonal windshadow	Normalized_TOTAL_STUDENT	Normalized_LST_Mean	Normalized RdDensity	Exposure	Zonal Sensitivity	Adaptive Capacity	Common SCI	Contextual _SCI
0	0.023657289	0.890342816	0.443057431	0.013432836	0.026053369	0.629700115	0.401766468	0.600503462	0.025482461	0.593258195	0.445659604	0.354800086	0.543990015	0.23275729	0.006252398	0.07
0.09255079	0.054987212	1	0.742534969	0.010447761	0.00785641	0.735574919	0.354499575	0.446714758	0.043501439	0.582658125	0.384781032	0.336980199	0.512263084	0.318062857	0.00450742	0.01
0	0.039641944	0.833794381	0.909039815	0.007462687	0.003024776	0.651736979	0.216974113	0.655774435	0.040302804	0.666457375	0.207348452	0.304702877	0.508161842	0.298827267	0.003180502	0.00
0	0.004475703	0.836753764	0.393290443	0.010447761	0.025863422	0.757274193	0.465924386	0.564747127	0.009915769	0.541108049	0.342326006	0.297783275	0.595981902	0.211805182	0.001911002	0.05
0	0.572250639	0.981972469	0.730095408	0.004477612	0.049523636	0.854115276	0.148106463	0.628615612	0.015353449	0.590598699	0.236036501	0.280662883	0.54361245	0.389719961	-0.000682332	-0.06
0	0.073529412	0.77701176	0.893093694	0.013432836	0.065470488	0.56253764	0.097789478	0.608547429	0.041049152	0.647603594	0.213983677	0.300878808	0.422958182	0.303756365	0.003258486	0.00
0	0.054347826	0.808364721	0.902188841	1	0.051081385	0.69986747	0.345779575	0.717872456	0.081885062	0.422318454	0.309604727	0.271269414	0.587839834	0.469330462	-0.015314037	-0.12
0.227990971	0.018542199	0.814395219	0.592861758	0.007462687	0.010094805	0.819508942	0.342133878	0.730371138	0.167182002	0.63607197	0.254069804	0.352441259	0.630671319	0.27855794	0.018861527	0.05
0	0.041560102	0.894882336	0.817593192	0.041791045	0.005827423	0.666126372	0.175955777	0.831256809	0.056082738	0.705963838	0.408930235	0.390325604	0.557779653	0.300275683	0.011120181	0.05
0	0.17455243	0.632309095	0.839348883	0.001492537	0.032379169	0.775581882	0.036679533	0.732431554	0.078899669	0.746813791	0.13831348	0.321342313	0.514897656	0.280013686	0.008917481	0.02
0	0.012148338	0.782919792	0.598772176	0.007462687	0	0.725850543	0.538246971	0.763324605	0.031026762	0.723084625	0.369874002	0.374661796	0.675807373	0.233550499	0.008259905	0.10
0	0.409846547	0.084137545	0.885364281	0.202985075	0.08701411	0.625540479	0.033676071	0.653999578	0.05533639	0.476457005	0.052866212	0.194886535	0.43773871	0.278224593	-0.002866706	-0.04
0.0248307	0.017902813	0.675504447	0.698219347	0.004477612	0.003207641	0.764132059	0.176379695	0.706313921	0.113018445	0.567337625	0.185574749	0.288643607	0.548941892	0.237357093	0.010428122	0.03
0	0.021099744	0.798446087	0.926352869	0.637313433	0.010210305	0.748231942	0.425499535	0.399514111	0.042541849	0.414689242	0.210267854	0.222499648	0.524415196	0.39890374	-0.006983835	-0.09
0	0.334398977	0	0.889776011	0.064179104	0.023607193	0.685420063	0.235325537	0.409104488	0.068130931	0.414324998	0.131717467	0.204724465	0.443283363	0.218660214	0.001045838	-0.01
0	0.039002558	0.845972711	0.387260915	0.020895522	0	0.728613282	0.419535004	0.619864338	0.093826634	0.602944712	0.446722153	0.3811645	0.589337541	0.215521951	0.024977315	0.10
0.837471783	0.173913043	0.89802089	0.820878527	0.001492537	0.015186524	0.677877626	0.117056566	0.890275191	0.0508583	0.205713079	0.137264273	0.131278551	0.561736461	0.457827217	-0.019065082	-0.18
0	0.01342711	1	0.690785874	0.001492537	0.125087742	0.628745698	0.175336856	0.740220715	0.11611046	0.53709426	0.374381967	0.342528896	0.514767756	0.305132211	0.013305911	0.02
1	0.042838875	1	0.436536081	0.020895522	0.157601278	0.797735095	0.54349296	0.60470337	0.19959484	0.665835678	0.476434281	0.447288266	0.648643809	0.442978626	0.014187378	0.00
0	0.029411765	0.959689217	0.745426641	0.004477612	0.002383764	0.794425297	0.658896244	0.604514462	0.016419661	0.672171943	0.4426716	0.377087735	0.685945334	0.2902315	0.003441901	0.06
0.101580135	0.157928389	0.927889878	0.928194539	0.089552239	0.177695081	0.799138216	0.099510586	0.870299265	0.066958098	0.596910843	0.211313793	0.291727578	0.589649356	0.397140044	-0.002471873	-0.06
0	0.326086957	0.851341182	0.155062274	0.01641791	0.203135853	0.693537406	0.070766805	0.908616842	0.218253545	0.609005552	0.414522408	0.413927168	0.557640351	0.258674029	0.052813498	0.09
0	0.143222506	0.890342816	0.887008197	0.358208955	0.030942063	0.501322185	0.13296834	0.766109901	0.177630877	0.556600604	0.257631596	0.330621026	0.466800142	0.38495409	-0.008640036	-0.03
0	0.244245524	0.974505223	0.924303335	0.371641791	0.026238482	0.633892333	0.15502269	0.809835518	0.082418168	0.429324382	0.206438463	0.239393671	0.532916847	0.423489059	-0.015252121	-0.10
0	0.112531969	0.981972469	0.521863831	0.031343284	0.533033433	0.688448892	0.239482057	0.565836643	0.049152362	0.559454498	0.314383016	0.307663292	0.49792253	0.363457498	0.005277806	-0.03
0.284424379	0.296675192	0.851341182	0.661931412	0.062686567	0.43113453	0.645452635	0.051342867	0.672367589	0.265380104	0.56847477	0.786793752	0.540216209	0.456387697	0.431365544	0.065342557	0.05
0	0.176470588	0.974505223	0.754083661	0.028358209	0.01357549	0.698189982	0.271983874	0.817216111	0.244055869	0.641515771	0.263527206	0.383032949	0.595796656	0.324498862	0.016068139	0.03
0	0.35741688	0.879067652	0.9261392	0.056716418	0.123452077	0.658691465	0.113078092	0.906934242	0.006290649	0.59090706	0.086131117	0.227776276	0.559567933	0.390465371	-0.000662713	-0.09
0.106094808	0.333120205	0.959689217	0.745295279	0.068656716	0.066448757	0.729360473	0.15995498	0.872570555	0.130291076	0.582300444	0.294663404	0.335751641	0.587295336	0.379884164	-0.000532802	-0.03
0	0.251918159	0.808364721	0.883413986	0.13880597	0.312277999	0.84939749	0.24268264	0.742597441	0.139460497	0.654556119	0.197370133	0.33046225	0.611559191	0.399130139	0.001319653	-0.04
0	0.232736573	0.88598389	0.849242249	0.1	0.139804907	0.659335765	0.125157645	0.63519664	0.200127945	0.507097441	0.21001943	0.305748272	0.473230017	0.36796127	-0.011013863	-0.03
0	0.329283887	0.935000816	0.69479265	0.065671642	1	0.669778918	0.092874145	0.706067901	0.524576181	0.516243885	0.176110636	0.405643567	0.489573655	0.504124833	-0.030830674	-0.05
0	0.230179028	0.884567478	0.861600787	0.047761194	0.004264114	0.728375203	0.171549146	0.865958774	0.046806696	0.579427223	0.162043431	0.262759116	0.588627708	0.3380621	-0.00159547	-0.04
0	0.000639386	0.927889878	0.623290858	0.001492537	0.006495193	0.751104978	0.629171091	0.393745826	0.05267086	0.789186864	0.237434729	0.359764151	0.591340632	0.259967975	0.010673658	0.06
0	0.02173913	0.942991945	0.784390428	0.008955224	0.036136453	0.670331359	0.357057922	0.506027484	0.058001919	0.812411651	0.261996558	0.377470043	0.511138922	0.29903553	0.010764504	0.04
0	0.017902813	0.855779756	0.681461477	0.001492537	0.012760487	0.812067698	0.345484952	0.675649316	0.056829086	0.623707089	0.148266874	0.276267683	0.611067322	0.261566178	0.004242841	0.01
0	0.281969309	0.549311723	0.796927191	0.023880597	0.067977846	0.880624674	0.362821092	0.736376656	0.174219	0.511929915	0.178458942	0.288202619	0.659940807	0.286677778	0.002574376	0.00